MARKET STRUCTURE

of the

ALASKA SEAFOOD PROCESSING INDUSTRY

Volume II

Finfish

by

Franklin L. Orth

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University of Alaska

Sea Grant Report 78 - 14

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Alaska Sea Grant College Program
University of Alaska
Fairbanks, Alaska 99701

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PREFACE AND ACKNOWLEDGEMENTS

One will notice, first of all, that this second volume of Market Structure of the Alaska Seafood Processing Industry is fairly large. This is because the Basic Industry Conditions (Chapters III through XIV) for the finfish have a longer history than most of the shellfish fisheries. The Appendix also includes interesting and, it is hoped, revealing information about the nature of each fishery.

The second observation is that the authors are by no means the principal sources of information, nor are they each, singly, experts on the fishing industry in the North Pacific. State and federal officials, people in the fishing and processing sectors of the industry and other researchers were generous with their own valuable time in helping us. In this respect, the following draft reviewers deserve recognition for their help in Volume II:

John Blackwell	Seward Fisheries
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Bud McCartney	Washington Fish and Oyster Company
Richard J. Myhre	International Pacific Halibut Commission
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Don E. Reinhardt	Halibut Producers Cooperative

In addition, Carl Rosier, Alaska Department of Fish and Game; Fred Smith, Oregon State University; Walt Yonker, National Food Processors Association; and Peter Rogers, Frank Orth and Associates provided needed input for the formation of Chapers I and II of Volume II. To the many other people who are not listed here but who have made valuable observations from which we have benefitted, we give our sincere thanks.

The third observation is that, where applicable, the authors went off on topics seemingly unrelated to the present day fishery. These topics ranged from Bretton Woods to chicken production; soybean subsidies to consumer reactions to beef and poultry prices. The defense that can be offered for these digressions is that the fishing industry (and one might add all agricultural commodities) is not a simple or easy one to analyze or second guess. It is so complex, in fact, that to properly define industry conditions, one must dig around in areas not directly akin to the fishing industry.

All errors and ommissions are the responsibility of the authors. Opinions expressed by the authors do not reflect any official position, and any reference to specific companies does not constitute endorsement.

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CHAPTER I

INTRODUCTION

The Fishery Conservation and Management Act of 1976 formally incorporates economic analysis into the legal and institutional framework for fisheries management. The implementation of this broadened management concept can occur only gradually as economic information needs are defined and as systems for collection, storage, and dissemination are devised. In the meantime, it would be useful to exploit existing data sources to provide meaningful economic information and insights to those that are responsible for implementing the Act.

This report is directed at the near-term goal of providing as complete a picture of the Alaska seafood processing sector as institutional data and industry sources will allow. The objective of this research effort has been to assess the economic structure of Alaska seafood processing as it has evolved since statehood, within the context of changing regulatory, technological, and biological environments. This "in context" approach is necessary since economic structure is primarily determined by the dynamic forces that constitute an industry's operating environment. Accordingly, this report contains information on the basic industry conditions corresponding to each major processing industry--historical overview, the resource, harvesting and processing methods, and marketing. This information will provide the background for interpreting present structural conditions and structural changes that have occurred since statehood. Many readers will need to use this background material for occasional reference only. For those not knowledgeable about a particular fishery, a complete reading should prove to be beneficial.

Another objective of this work has been to provide management agencies and industry executives with a baseline inventory and description of the primary components of the seafood processing sector. This should provide information for current decision making and build the framework for annual or periodic updating for all or selective segments of the seafood processing sector. Included in the baseline inventory is the geographic distribution of plants and firms and, within regions, the number and size distribution of plants and firms in total, and by major species and process forms. Figure 1 shows how this research was conceptualized and conducted.

Background and Scope of the Study

In 1976 a research effort was initiated under funding by the Alaska Sea Grant Program to develop a comprehensive description of the economic structure of the Alaska seafood processing industry. Two factors justified the research, although they are not the only possible benefits from increased knowledge. The first was the observation that the efforts of Alaska fisheries resource managers could benefit by an improved understanding of the seafood processing sector. Business decisions by processing firms and resource management decisions by state and federal agencies are, to a large degree, interdependent. Since this observation is becoming increasingly apparent, it seems that a basic

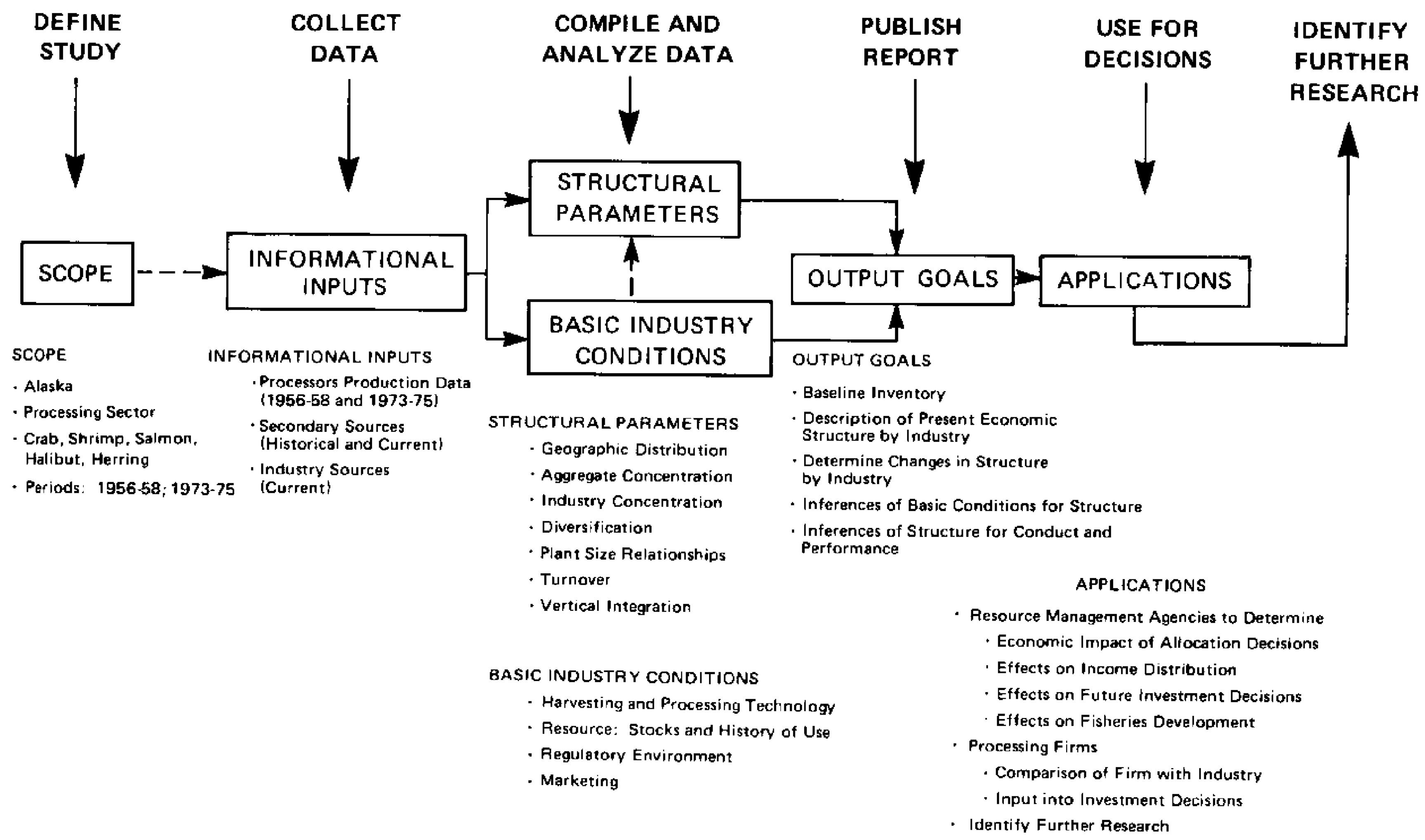

FIGURE 1. CONCEPTUALIZATION OF MARKET STRUCTURE STUDY

knowledge of the seafood processing sector is mandatory for sound resource management. The second justification was that, short of a descriptive study of this type, there were no ready vehicles for providing the information needed by managers.

The scope of this study is limited in four ways. First, the study focuses primarily on the processing sector of each fishery; no in-depth treatment of the harvesting and marketing levels was attempted. Second, this focus is on Alaska seafood processing only. Processing activity in Washington, Oregon, California, British Columbia, and the United States is discussed only as it pertains to Alaska processing. Because these states and regions compete in varying degrees for final-consumption markets, an assessment of economic structure for only one production region must be interpreted cautiously when used as input into evaluations of competitive conditions in these markets. In cases where further processing occurs outside Alaska, as is often the case for frozen whole halibut and salmon, the assessment of final market-competitive conditions based only on primary-production-area data would be even more tenuous. Second, economic structure in Alaska will be indicative of competitive conditions on the buying side of the market, i.e., in the acquisition of raw fish for processing. Third, the time periods compared in this study are the three-year periods immediately prior to statehood and the most recent three-year period for which complete data were available. Data were not sufficient to permit coverage of the intervening years. Fourth, the study describes the economic structure of the processing industry for each of Alaska's major fisheries--salmon, halibut, herring, crab, and shrimp (Figure 2)--but it does not attempt coverage of the other miscellaneous species.

Data Resources

Most of the data for measuring structure were obtained through the cooperation of the Division of Commercial Fisheries of the Alaska Department of Fish and Game, and the Alaska Regional Office of the National Marine Fisheries Service. These data cover the years 1956 to 1958 and 1973 to 1976. In addition, an industry survey was conducted during the spring and early summer of 1978 to acquire descriptive information not available from institutional sources. On a less formal individual basis, industry executives were approached throughout the period of this study for factual and interpretive input. Although experience varied widely, most were very generous with their time and knowledge.

While Alaska is not unique in this regard, data on the economic dimensions of its fisheries is sparse. This is a reflection of the historical orientation of fisheries management toward biological research. The best fisheries data is at the harvesting level, where it is used for stock assessment work. Available data progressively decreases as the fish are processed and marketed. Since this is a study of the processing sector, it is not surprising to find that the quality of the basic data is poor. Many judgments, some arbitrary, were required to made use of the raw

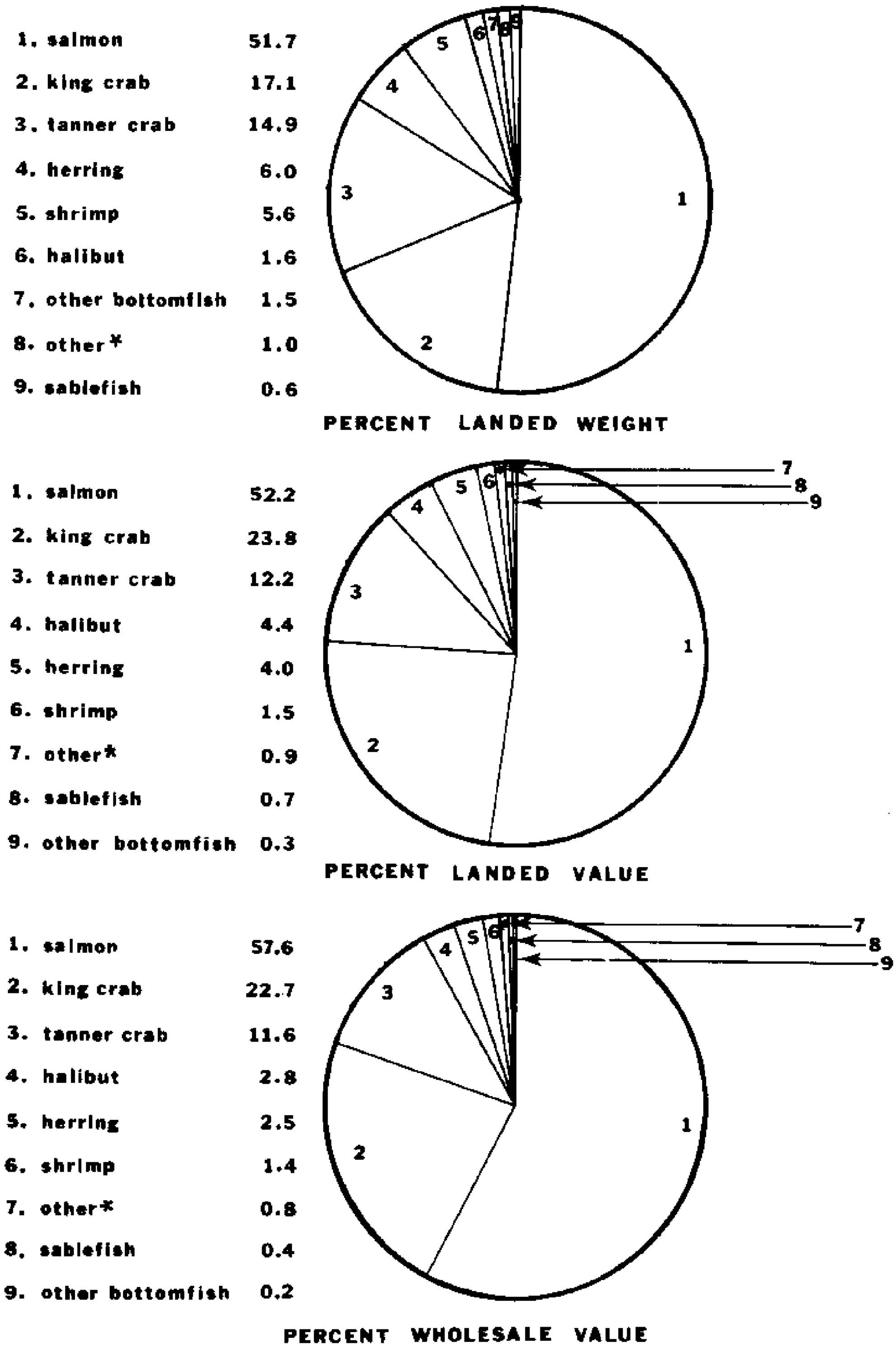

FIGURE 2. LANDED WEIGHT, EXVESSEL VALUE, AND WHOLESALE VALUE ESTIMATES OF ALASKA FISHERIES IN 1979. Data taken from Alaska Department of Commerce and Economic Development (1980).

*"Other" includes steelhead, herring roe on kelp, Dungeness crab, and other species.

production (quantity) data that were available. Value (price) data were found to be so poor that they were not generally usable mainly because most have been derived from highly aggregated quantity and value data with no reference to pricing points. A thorough description of data problems and how they were handled is provided in Appendix I, Volume I.

Production data by process form, product form, and species were the basic pieces of information used in this study, and were obtained from the commercial operators annual report forms. Plants not reporting production of any one of the five major species were excluded from the data base. Incomplete reporting, custom production, and changes in plant ownership each caused special problems for this study, as described in Appendix I, Volume I.

Annual fluctuations in the production of processed fishery products correspond to variations in landings. Some means of normalizing for these variations is required if economic structure is going to be accurately depicted. For example, in a poor salmon season, some plants might not operate at all even though in the previous and subsequent seasons they may have been significant producers. In this case, the size distribution of production over plants in a region would have been drastically different depending on the year of measurement. Table 1 shows the number of plants reporting production, as well as total harvest of fish and shellfish, in each year covered by this study. Table 2 shows how many companies produced in all three years of each period, two of three years, and only one of three years. As can be seen, there is ample room for distortion with the use of data for a single year. This is especially true at the regional level which can be expected to have experienced greater variation than revealed by statewide totals. To reduce the distorting effect of annual variations, three-year average production figures were used to measure concentration.

Reference to "Period 1" is to the period from 1956 to 1958 and "Period 2", from 1973 to 1975. The latest year for which data were available was 1975 when the study was begun. Data for 1976 were subsequently evaluated and are included in tables in Appendix IV of Volume I. The reader is cautioned that these single-year measurements may not be as representative of the distribution of production across plants and companies as the averages for Period 2, 1973 to 1975. Other discussions in Volume II draw from history as far back as 1878 and as recent as spring 1980.

Organization

The results of the study are presented in two volumes. King crab, tanner crab, and shrimp are covered in Volume I: Shellfish. Halibut, herring, and salmon are covered in Volume II: Finfish. With the exception of discussions on specific seafood markets, Chapters I and II of both volumes present the same material. This arrangement will allow the reader to have the overall results of the study available without having both volumes. Because reference is made to appendixes from Volume I in Volume II, references to appendixes in Chapters I and II are followed by a designation of which volume they are referring to.

TABLE 1

SEAFOOD PROCESSING PLANT COUNT AND HARVESTS BY YEAR
(In Millions of Pounds)

Year	Number of Shore Plants	Number of Floaters	Total Plants	Total Finfish	Total Shellfish
1956	137	22	159	410.4	14.3
1957	139	17	156	349.4	16.0
1958	99	8	107	356.4	20.8
1973	149	29	178	196.1	264.9
1974	149	35	184	187.0	271.7
1975	154	31	185	191.2	246.5
1976	134	37	171	293.5	317.1

Source: Compiled from data provided by Alaska Department of Fish and Game; 1956 and 1957 harvest figures are taken from Fisheries of the United States and Alaska; 1958 harvest figures are from Alaska Fisheries 1958.

TABLE 2

CONTINUITY OF COMPANY OPERATION IN PERIOD 1 AND PERIOD 2[1]

Number of Years in Period for Which Production Reported	Number of Companies	
	Period 1	Period 2
1	65	78
2	54	49
3	55	82

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Period 1 = 1956 - 1958, Period 2 = 1973 - 1975.

The remainder of Chapter I in Volume II will provide a brief review of other seafood processing structure studies (more detailed treatment of this material is provided in Appendix II of Volume I) and a description of the regulatory environment facing the seafood processing sector with special attention given to the implications for finfish processors. The review of other studies is intended to allow the reader to place the results of the present study into broader perspective. Chapter II of Volume II describes the structure of the Alaska seafood processing sector and also gives a detailed description of the finfish processing industries. Chapters III through VI present descriptive information on the basic industry conditions of the halibut processing industry. Chapter VII through XIV hold the same material for herring and salmon. The basic industry conditions portion for each species in Volume II is divided into discussions on history; the resource; harvesting and processing methods; and a discussion of markets, prices, demand and projections.

The appendixes to Volume I provide: Appendix I--detailed information on how data problems were treated in the course of the research; Appendix II--a conceptual overview of economic organization (structural) in general, and a review of literature on the seafood processing structure in the U.S., and a glossary or terms; Appendix III--the compiled results of the industry survey; Appendix IV--statistical tables for Period 3 (1976 only) comparable to those shown in the main body of this report for Period 1 (1965 to 1958) and Period 2 (1973 to 1975).

In Volume II, Appendixes I through IX cover material relevant to the halibut industry. Supplemental tables regarding the herring fishery and the processing industry are found in Appendixes X through XII. Additional materials on the salmon industry are contained in Appendixes XIII through XVIII. Personal contacts are listed in Appendix XIX.

Structural Elements of the U.S. Seafood Processing Industry: A Literature Summary

Relatively few studies have been conducted on structural aspects of the U.S. seafood processing industries. Those that presently exist assess structural components on national and regional bases (Capalbo 1976) or by particular fish and shellfish species (Alvarez et al. 1976; Jensen 1975; Kolhonen 1976; Anderson et al. 1977). The scope of the Capalbo study is limited in that it does not evaluate structural elements in all regions and because such elements, when assessed, are aggregated by process form sector. The latter feature renders interpretation of structural parameters more difficult as process form sectors rarely conform to the concept of an industry or market. The specific-species studies, while being free of the drawbacks, are simply too limited in number or scope; a few species and/or regions are covered by these works but not enough to adequately characterize the economic structure of regional or national markets for these or similar fish products.

In general, the particular species studied are consistent with, and thus tend to support, the study by Capalbo (1976). For this reason, a summary of the Capalbo study is used to describe structural elements of the U.S. processing industry. The other studies are discussed in Appendix II of Volume I.

A summary of structural elements is presented in Table 3. Most of the structural elements assessed by Capalbo are included in the table; the only regions for which there were coverage for such elements are the New England and Middle Atlantic regions. It can be seen in the table that concentration increased from 1965 to 1974, at both national and regional levels, in all four process form sectors. The frozen, canned, and cured process form sectors were generally more concentrated than the fresh sector and exhibited greater inequality in plant size. Firms in most sectors did not extend production (diversity) to other process forms, either at the national or regional level. Backward vertical integration appeared to be relatively low in the fresh sector, moderate in the frozen and cured sectors, and moderate to relatively high in the canned sector.[1] Forward integration was generally low to moderate in all sectors but the fresh sector at the national level.

All sectors experienced a decline in plant numbers from 1965 to 1974. Most entry and exit activity was accounted for by plants with annual sales in the $1,000 to $199,999 range. The mode plant size in the fresh sector was relatively small ($1,000 to $199,999) while it was comparatively large ($1,000,000 +) in the frozen and canned sectors.

It should be reiterated that the above description of structural elements is general and not applicable to all species within a process form sector. The information presented is highly aggregated and should be interpreted with care.

Alaska Fishing Industry: Regulatory Environment

Alaska's fishing industry is subject to direct and indirect regulation by many state and federal agencies and departments. In some cases this complex organizational structure leads to overlapping jurisdictions between federal and state government, and contradictory and undefined government policies and objectives causing inefficient management of fisheries resources.

A review of the federal and state regulatory agencies that affect Alaska fisheries is included. This will briefly discuss the role of each and point out some of the constraints to successfully managing Alaska fisheries. This review is not intended to be comprehensive, but is intended

[1]Capalbo did not explicitly consider this structural aspect. The information for this element was derived primarily from other studies (Alvarez et al. 1976; and Jensen 1975).

TABLE 3

SUMMARY OF MARKET STRUCTURE ELEMENTS OF U.S. SEAFOOD PROCESSING INDUSTRY BY NATIONAL AND REGIONAL PROCESS FORM SECTORS

STRUCTURAL ELEMENTS[1]	Fresh Process Form Sectors			Frozen Process Form Sectors			Canned Process Form Sectors		Cured Process Form Sector
	National	New England Region	Middle Atlantic Region	National	New England Region	Middle Atlantic Region	National	Pacific	National
Trend in concentration, 1965-74	increase	increase	increase	increase	increase	increase	increase	increase	increase
8-plant concentration ratio >.70	no	no	no	no	yes	yes	no	yes	no
4-plant concentration ratio >.30	no	yes	yes	no	yes	yes	yes	yes	yes
Inequality of plant size[1]	moderate	moderate	moderate	moderate	great	great	great	great	great
Product extension [2]	moderate	high	moderate	low	moderate	moderate	low	low	low
Vertical integration									
backward	low	low	low	moderate	moderate	moderate	moderate	moderate-high	---
forward[3]	moderate-high	moderate	moderate	low	low	moderate	low	moderate	moderate
Change in total number of plants, 1965 and 1974	decrease	decrease	decrease	increase	decrease	decrease	decrease	decrease	decrease
Size class[4] of most entry-exit activity; 1965 to 1970	2	2	2	2	2	2	2	2	...
1970 to 1974	2	2	2	2	2	2	2	2	...
Mode plant size (by size class)	...	2	2	...	2	5	...	6	...
Number of plants by size class 1	...	1	-	...	-	-	...	-	...
2	...	118	25	...	31	9	...	27	...
3	...	16	12	...	6	4	...	7	...
4	...	15	8	...	11	2	...	5	...
5	...	13	5	...	27	9	...	30	...
Total	...	163	50	...	75	24	...	69	...

Source: Adapted from Capalbo, 1976.

[1] For further detail see Capalbo, 1976, pp. 78,97.

[2] Descriptions:
low 20%
moderate 20-40 % — % of plants in top 20 that extended production
high 40%

[3] Descriptions:
low 0-9%
moderate 10-25% — % of plants in top 20 that were vertically integrated
moderate-high 26-35%

[4] Size class of plants is by value of annual production:
Class 1 $0 - $99
Class 2 $1,000 - $199,999
Class 3 $200,000 - $499,999
Class 4 $500,000 - $1,000,000
Class 5 $1,000,000 - $10,000,000
Class 6 $10,000,000 +

only to illustrate the general responsibilities of each agency. A summary of these agencies and user groups is shown in Figure 3.

Federal Agencies

North Pacific Fishery Management Council (NPFMC). NPFMC is one of the eight regional management councils organized under the Fishery Conservation and Management Act of 1976. The NPFMC has authority over the fisheries of the Arctic Ocean, Bering Sea, and the Pacific Ocean from three to 200 miles seaward of Alaska. Although the NPFMC is not a federal organization, per se, its organization and funding were both provided for by acts of Congress and is, therefore, included as a federal agency.

The Environmental Protection Agency (EPA). The Federal Water Pollution Control Act of 1948 was amended, reorganized, and expanded into P. L. 92-500, October 18, 1972 (U.C.S. 33 Sec. 1151) which defined the existence and activities of the Environmental Protection Agency (EPA). Public law 92-500 outlines the goals of the Act, the jurisdiction of the EPA, methods of regulation, channels of litigation, punishments for non-compliance, methods of granting funds for research, construction, and methods of determining the extent of pollution control necessary to assure interim goals. This Act was further amended in December of 1977 to include a further charge to the EPA:

> P. L. 95-217, Sec. 74, Dec. 27, 1977, 91 Stat. 1609 provides that: "The administrator of the Environmental Protection Agency shall conduct a study to examine the geographical, hydrological and biological characteristics of marine waters to determine the effect of seafood processes which dispose of untreated natural wastes into such waters. In addition such study shall examine technologies which may be used in such processes to facilitate the use of nutrients in these wastes or to reduce the discharge of such wastes into the marine environment. The results of such study shall be submitted to Congress not later than January 1, 1979 (C.F.R. 33)."

The overall objective of the EPA is to eliminate discharge of pollutants into the environs of the United States by means of the best practical control technology currently available by 1983. However, two key terms, "pollution" and "best practicable control technology currently available" remain major points of contention that are even now undergoing further study and definition. At the present time, bioassays determine the extent to which pollution is a problem in an industry, but, not every case of discharge is clearly definable in terms of the assimilative power of the environment or the need of the environment of elemental nutrients or trace chemicals.

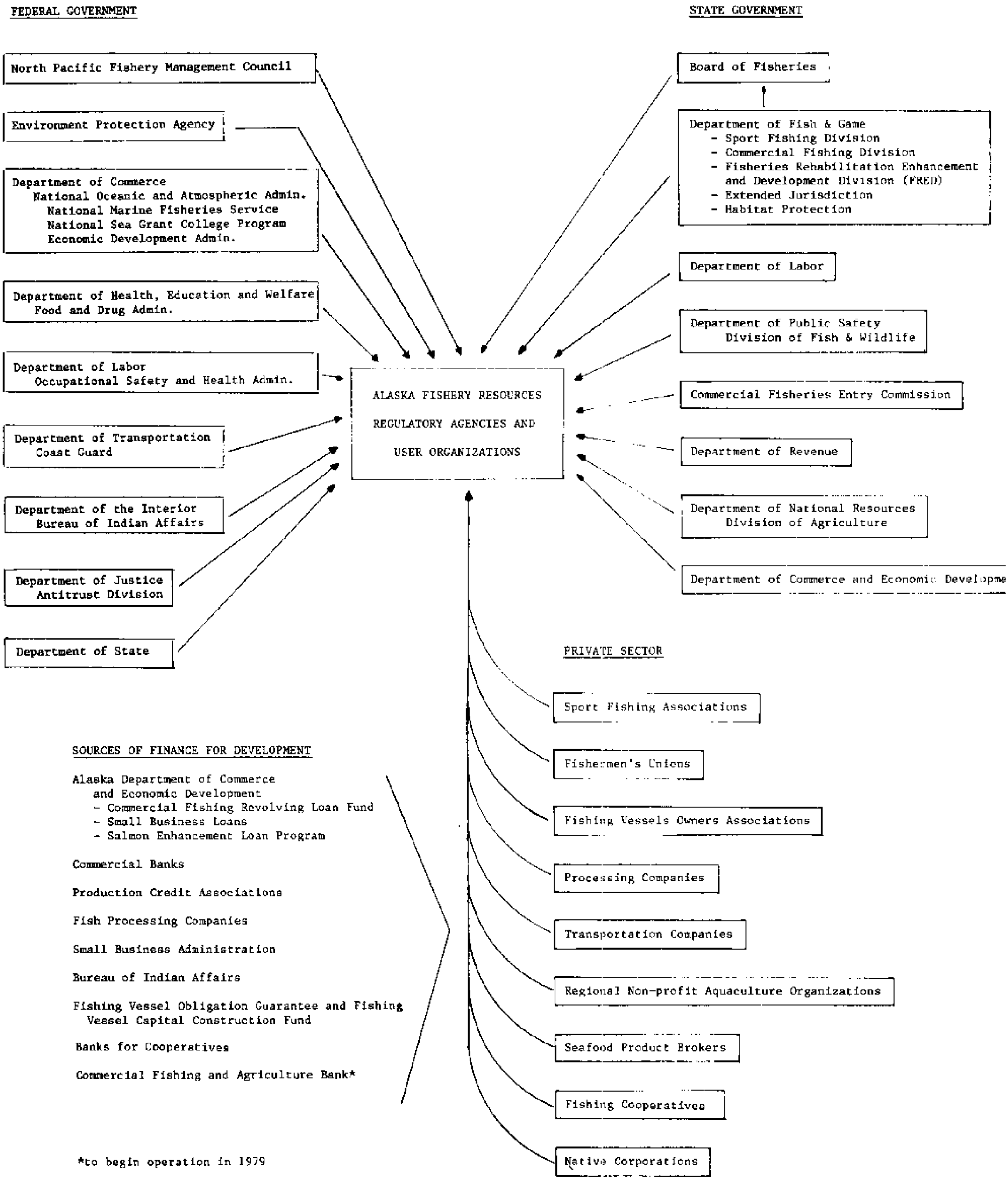

FIGURE 3. AGENCIES AND ORGANIZATIONS AFFECTING ALASKA MARINE RESOURCES DEVELOPMENT

However:

> The function of the administrator of the Environmental Protection Agency under the effluent limitations provisors of the Chapter (P.L. 92-500) is to set interim levels of pollutant charge allowable until absolute cessation is required. (American Frozen Food Institute v. Train. 1976. 539 F.2d 107. 176 U.S. App. D.C. 105) (C.F.R. 33).

This change places the EPA in the unenviable position of trying to discern what "pollution" means in different industries. The other major contention is the use of the term "best practicable control technology currently available," which has in the past implied that zero discharge as a goal in 1983 should occur irrespective of cost to the industrial sector. However, several economists have implied that a social optimum may not be one that allocates the cost of cleanup totally to industry. Society, in general, may not only acquiesce, but be willing to bear some of the social burden of an occasional pollution problem, rather than to bear a further cost that would undoubtedly occur through complete cessation of effluent discharge. The courts have hinted at this as being a possible consideration in the future:

> No formal cost-benefit analysis is required in determining "best available" 1983 technology in setting effluent limitations, though the administration is to take cost into consideration (American Meat Institute v. Train. 1976. 539 F.2d 107. 1976 U.S. App. D.C. 105) (C.F.R. 33).

The moot question here is what the definition of costs are; whether they are in some sense social costs or costs incurred by the firm.

The status of the EPA's enforcement activities in Alaska at this time is being decided in a number of ways. In order to meet the December, 1977 order, national guidelines were developed for crab and shrimp and also for finfish processing, but have been challenged by the Ninth Circuit Court in San Francisco (Lameroux 1978). The implication here is that in the absence of national guidelines, which have been suspended pending further study, permitting of discharge by the EPA as per P.L. 92-500 is the only regulatory method available for controlling discharge of potential pollutants. An example of the regulatory action of the EPA in Alaska is the regulation enacted in 1973 to stop processing wastes in Kodiak from being released into the ocean. Faced with the possibility of being shut down, the processing companies found a solution by selling (or paying to have taken away) wastes to Bio-Dry, a reduction processing plant. The EPA is presently in the process of enacting a similar regulation at Dutch Harbor. As the regulation now stands, the plants there had to have screens installed by November 1, 1978, to filter out solid particles from the waste water disposal systems, or face fines and other penalties. As of this writing, the EPA is carrying out litigation against processors in Cordova also.

U.S. Department of Commerce (USDC). The USDC encourages, serves, and promotes the nation's economic development and technical advancement. It offers assistance and information to domestic and international businesses; provides social and economic statistics and analyses for business and government planners; assists in the development and maintenance of the U.S. Merchant Marine, and provides research for and promotes the increased use of science and technology in the development of the economy.

National Oceanic and Atmospheric Administration (NOAA). The purposes of NOAA are to explore, map, and chart the global ocean and its living resources; and to describe, monitor, and predict conditions in the atmosphere and ocean. Among its principal functions, NOAA provides special services in support of marine activities. It prepares and issues nautical charts; predicts tides, currents, and the state of the ocean; conducts biological research and surveys the living resources of the sea; analyzes economic aspects of fisheries operations with an eye to improving man's ability to use and conserve those resources; and protects marine mammals.

National Marine Fisheries Service (NMFS). NMFS is a field organization of NOAA. It provides research and informational services in the areas of resource research, resource utilization, resource management, and international fisheries.

National Sea Grant College Program. The Sea Grant College Program is a federal-state-university partnership, which administers and supports research, education, and advisory services in the development of marine resources and technology in American universities.

Economic Development Administration (EDA). The primary function of the EDA is the long-range economic development of areas with severe unemployment. It aids in the development of public facilities and private enterprise to help create new, permanent jobs.

U.S. Department of State (USDS). The USDS advises the President in the formulation and execution of foreign policy. The department determines and analyzes the facts relating to our overseas interests, makes recommendations on policy and future action, and takes the necessary steps to carry out established policy. It is responsible for negotiation or renegotiation of treaties with other countries which pertain to the fisheries within the fishery conservation zone.

Department of Health, Education, and Welfare (HEW). This is the department of the federal government most involved with human concerns and the welfare of the individual. Some programs within HEW which have direct effects on Alaskan fisheries are described below.

Food and Drug Administration. The FDA is charged with the enforcement of the Federal Food, Drug, and Cosmetic Act and the Fair Packaging and Labeling Act. The Administration is divided into:

Bureau of Biologics. The activities of this bureau are directed toward protecting the health of the nation against impure and unsafe foods. Their responsibilities include: regulation of biological products shipped in interstate and foreign commerce; inspection of manufacturers' facilities; establishment of written and physical standards; testing of products submitted for release; approval of licenses of manufacturers of biological products; carrying out research related to development, manufacture testing, and manufacture of new and old biological products.

Bureau of Foods. This bureau conducts research and develops standards on the composition, quality, nutrition and safety of foods; conducts research designed to improve detection, prevention, and control of contamination that may be responsible for illness or injury conveyed by foods; reviews industry petitions.

Enforcements only generally apply to food products and do not specifically address fish. However, some unfortunate occurrences in the canning industry, and a general need for quality controlled seafood packing have forced the FDA to pay special attention to fish processing firms with the help of the National Food Processors Association (formerly the National Canners Association). This interaction between industry, other government agencies, and the FDA has resulted in two inspection programs now in use. However, for the most part, inspections of all interstate fish processors who ship would be a near impossibility with the staff and resources available to the FDA. Nevertheless, they may supply a warrant for search and may prevent shipment of any interstate or intrastate (in a case where the state has an ill-defined program of processor monitoring, the FDA assumes jurisdiction) merchandise suspected to be adulterated. A specific application of FDA regulations to halibut has concerned the levels of mercury in halibut flesh. A recent court decision in Pensacola, Florida, overturned the tolerance level set by the FDA at 0.5 ppm and raised it to 1.0 ppm, and may, in the future, carry with it a variance of 0.2 ppm. Heretofore, the only recourse for processors with halibut that has been rejected by FDA has been to sell intrastate or to countries with a higher tolerance level.

The NMFS, in conjunction with the FDA, has responded to consumer pressure for more quality control of seafood by instituting a non-compulsory program of seafood product inspection. As of this writing, few processors in Alaska participate in this program. Although the inspection, since its inception, has been non-compulsory, those who choose to apply for inspection have available an inspection and consulting service that provides coverage of the plant's operating facilities. Although the plant must pay for the laboratory equipment, inspectors' salaries, and analyses that are performed, the benefit is in the advertisement of their product where they are allowed to display the government seal and advertise that they are under some form of government inspection.

However, for sales of canned salmon to the Defense Personnel Support Center (DPSC) or for any potential government sales, the cans are required to be inspected by the NMFS program, yet the cans are not allowed to include a government inspection seal, even though the product may not, in the end, be actually sold to DPSC. This results in the negation of a major selling feature of the program.

The following quote from the quality guidelines for halibut steak gives the reader some idea of the quality standards expected from fish inspected under this program.

> Frozen halibut steaks are clean, wholesome units of raw fish flesh with normally associated skin and bone and are two ounces or more in weight. Each steak has two parallel surfaces and is derived from whole or subdivided halibut slices of uniform thickness which result from cutting perpendicularly to the axial length or backbone, of a whole halibut. The steaks are prepared from either frozen or unfrozen halibut (*Hippoglossus spp.*) and are processed and frozen in accordance with good commercial practice and are maintained at temperatures necessary for the preservation of the product... C.F.R. 50, Sec. 265.1.
>
> It is recommended that the thickness of halibut steaks...be not less than 1/2 inch thick and not greater than 1 1/4 inches... C.F.R. 50, Sec. 265.6(b).
>
> The grade is ascertained by observing the product in the frozen, thawed, and cooked states... C.F.R. 50, Sec. 265.11.

A point system and a subjective analysis based on organoleptic (tasting, smelling) characteristics are used in scoring the halibut steak. Some of the characteristics measured include:

1. Percentage glaze
2. Excessive drip
3. Discoloration of drip
4. Discoloration of light meat
5. Discoloration of dark meat
6. Color uniformity
7. Dehydration
8. Holes in steak surface
9. Workmanship defects
10. Texture defects.

The successful inspection of halibut steaks set out by a processor does not excuse that same processor from a failure to adhere to the provisions of the Federal Food, Drug and Cosmetic Act. It also does not exempt the processor from abiding by the Alaska Administrative Code pertaining to seafood processors.

The history of the non-compulsory seafood inspection program seems to have been blurred by a number of industry and government interpretations. One contact claims that the non-compulsory program was a compromise between no control and a full fledged government inspection program similar to USDA inspection of meat and poultry.

Several other sources, notably processors, took exception to this account stating that, to the contrary, the processing sector welcomed the inspection program and would have even appreciated legislative action more along the lines of the Wholesome Meat and Wholesome Poultry Acts.

A source from the Office of Ted Stevens, United States Senate, states, in a letter to the author that:

> ...various drafts and proposals regarding fish inspection have been floated in the congress for many years. Some of these have been incorporated into much broader bills dealing with the food industry in general, while others have dealt specifically with fish products. As is the custom in all areas of legislative concerns, test drafts are often floated and then discarded.
>
> To the best of my knowledge there is no connection between the Fisheries Service voluntary programs and the failure of Congress to pass a so-called 'wholesome fish act.' [2]

The Canned Salmon Control Plan (CSCP) is an agreement between the National Food Processors Association (NFPA), members of the salmon canning industry, and the Food and Drug Administration for the purpose of maintaining high quality canned salmon and decreasing the incidence of botulism (Hansen 1978; Dunkelberger 1978) and other related quality control problems. The plan was also formed in order to better utilize the limited resources of the FDA and to involve the NFPA in a far-reaching quality control program. In addition to unannounced inspections by the FDA, which are carried on from time to time, a routine check of the pack itself is performed in the winter of each year by the Northwest Laboratory of the National Food Processors Association. In these samplings, each packer submits cans of salmon for inspection by a panel of food technologists. The tests are organoleptic, and are graded by pertinent characteristics. In addition to this, the 1978 season will be the first time that those processors desiring to sell to DPSC will be required to contract with USDC for plant and product inspection, and arrangements for NFPA inspectors to be used were made to reduce the understaffing problem with the USDC (Billy 1978).

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[2]Letter from Steve Perles, Staff Attorney, October 27, 1978.

Department of Labor, Occupational Safety and Health Administration (OSHA). The purpose of OSHA is to develop and promulgate occupational safety and health standards; develop and issue regulations; conduct investigations and inspections to determine compliance with safety and health standards; and to issue citations and propose penalties.

Department of Transportation, U.S. Coast Guard (USCG). The USCG is responsible for search and rescue (life and property) in the high seas and in U.S. waters; law enforcement of laws governing navigation, vessel safety, marine environmental protection, and resource conservation (includes enforcement of safety standards on foreign vessels subject to U.S. jurisdiction); investigations, surveillance, operations, and boardings to detect violations.

Department of the Interior, Bureau of Indian Affairs (BIA). The BIA encourages and trains Indian and Alaska Native people to manage their own affairs and facilitates full development of their natural resource potentials, consistent with principles or resource conservation.

Department of Justice-Antitrust Division. This organization is responsible for enforcement of federal antitrust laws and prosecution of antitrust cases. It also represents the U.S. in judicial proceedings to review certain orders of the Interstate Commerce Commission, Federal Maritime Commission, and other agencies.

State Agencies

Board of Fisheries. This board is responsible for the establishment of and changes to commercial or sport fishing regulations; holding public meetings to allow public participation and input on proposed regulation changes.

Department of Fish and Game. This department is responsible for the management of Alaska's fishery resources, under guidelines promulgated by the Board of Fisheries.

Department of Labor. The workmen's compensation division administers the fishermen's fund which is comprised of 60 percent of the revenue collected from commercial fishing licenses. Medical and convalescent benefits are drawn against the fund through claims filed by fishermen injured or sustaining an illness while fishing.

Department of Public Safety-Division of Fish and Wildlife. This division is responsible for enforcement of harvesting regulations.

Commercial Fisheries Entry Commission. This commission was established in 1973 for the purpose of stabilizing the number of units of gear in the commercial fisheries at levels consistent with good fisheries management and fair dollar returns to the fishermen. Permanent entry permits were issued in 1975 on a point system measuring a fisherman's dependence on fishing; the permits are transferable.

Department of Revenue, Taxation (DRT). DRT is responsible for collecting tax revenue from Alaska fisheries operations. Each processing plant must complete an application for an Alaska fish processor license and pay an annual fee of $25. The state receives revenue from the finfish industry processing companies at the following schedule of rates:

Salmon cannery	- Three percent of the value (five-year average of the wholesale price of finished product) of the raw fish bought or obtained for canning during the year.
Salmon, other processes	- One percent of the value at the average prevailing price on the fresh fish market.
Herring processing	- One percent of the value (the actual price paid) of the raw herring.
Shore-based fish processor	- One percent of the value (the actual price paid) of the raw fishery's resources bought or obtained.
Floating fish processor	- Four percent of the value (the actual price paid) of raw fishery's resources.

Department of Revenue definitions are as follows: "'Shore-based fish processor' means cold storage and processing plants that are permanently attached to the land or have remained in the same location from January 1 through December 31 of the previous calendar year. Cold storage and fish processing plants which are not permanently attached to the land or did not remain in the same location the previous calendar year are classified as 'floating fish processor'." Floating processors which moor in the same location every year except for removal for drydock or repairs are apparently eligible for the shore-based rate unless they return to a different location to process according to the following Alaska statutes.

> Removal of vessels for repairs. Removal of vessels from the state for drydock repairs does not require reclassification under the higher rate of taxation. State vs. Wakefield Fisheries, Inc., Sup. Ct. Op. No. 779 (File Nos. 1397, 1398), 495 P.2d 166 (1972). Removal of vessels for periodic repairs and maintenance should not destroy the continuity of the period during which the vessels are deemed to be at fixed locations for one calendar year. Where, in to the yearly trips to Seattle for maintenance, the processors also sailed among several Alaskan communities to conduct their processing operations, they were disqualified from 'shore-based' status under this section. State vs. Reefer King Co., Sup. Ct. Op. No. 1344 (File Nos. 2605, 2606, 2607), 559 P.2d 56 (1976).

Discussions with persons at the Department of Revenue show that there is no clear definition of the amount of time a processor may remain in drydock outside the state each year and still retain shore-based status.

The state also obtains tax revenues from all people involved in any aspect of the fishing industry in Alaska by state tax on personal income. This is true for year-round or part-year residents.

Department of Commerce and Economic Development. This department is responsible for government assistance for fisheries development in Alaska and administers the fisheries revolving loan fund and other loan programs for which fishermen are eligible. Most ad hoc programs for fisheries development are administered by the department.

State Fish Inspection Regulations--Old and New

In the spring of 1978, the responsibility for inspection of seafood processing plants was transferred from the Department of Health and Social Services to the Agriculture Division of the Department of Natural Resources. This move was an important one in that the responsibility was transferred to a department already having extensive experience in inspecting other meat-processing operations.

The old Alaska Administrative Codes pertaining to Seafood Processing and Sale may be found in the 1973 edition of Title 7, AAC 15, Sec. 070-610. This would include Articles on food stores and markets, canneries, shrimp and crab packing, shellfish processing, cold storage, ice and frozen food locker plants, and general food standards. Although the Health Department had retained the right to inspection, some laws included were fairly out-dated and were in bad need of revamping to keep up with the advancing state of seafood processing in Alaska.

The new regulations are in final draft at this writing, and will probably be available for implementation soon. The Department of Natural Resources has retained sections on canneries, shrimp and crab packing, shellfish processing and cold storage, ice and frozen-food locker plants, and general food standards as an emergency measure until the new code is implemented. The new code, in contrast to the old, is well-defined, updated and comprehensive. The separate article for crab and shrimp has been eliminated, and now is included in Article 1 of the new document. A detention section details step-by-step procedures and a time frame for the handling of detentions and seizures. Adulteration and misbranding sections are included (Honsinger 1978).

CHAPTER II

ECONOMIC STRUCTURE OF THE ALASKA SEAFOOD PROCESSING SECTOR AND DETAILED FINFISH PROCESSING INDUSTRIES

Introduction

The collection and interpretation of economic information requires the use of a systematic framework. Industrial Organization, a branch of Economics, provides a conceptual framework that is applicable to seafood processing and all other industries in a private enterprise economy. The purpose of the framework is to provide a means for sorting and categorizing economic information in a manner which is useful for assessing the competitive environment in specific markets.

Economic structure studies are concerned with plants, firms, industries, and markets. In some instances, the interrelationship between or among entities is straightforward; in other cases, they are obscured by vertical integration, ownership interties, diversification, joint ventures, and custom-production arrangements. All of these complicating factors are common in the Alaska seafood processing sector. The difficulty of making precise and practical delineations among geographic markets and product markets further complicates a description of economic structure.

An industry is the basic competitive entity which consists of all sellers (firms) who produce a close substitute product and sell to a common group of buyers (Bain 1968)[1]. The "close substitute product" constitutes the "relevant product market," and "the common group of buyers" constitutes the "relevant geographic market." An industry, therefore, is all firms who compete in a particular geographic and product market. For example, the relevant product market might be canned salmon, and the relevant geographic market would be nationwide. The canned salmon industry would thus be defined as all firms who produce these species of salmon in cans and sell into the nationwide market system.

The market in which the firm competes as a seller is only one of several competitive environments. The seafood processing firms also compete with other firms for the acquisition of fish from harvesters. The competitive environment among processors in the acquisition of fish is a

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[1]As an alternative to a long digression in the body of this report, Appendix II of Volume I has been developed to provide a conceptual background for the interpretation of information presented in this report, as well as for assisting the reader who wishes to obtain a general understanding of economic organization. Appendix II also provides an overview of the results of other studies of seafood market structure. This information is intended to allow the reader to place the results of the present study in broader perspective. Finally, Appendix II contains a glossary of technical terms to assist readers as necessary, although an effort has been made to minimize the use of economic jargon.

significant source of public interest in seafood processing market structure. Where buyer concentration exists, whether due to geographic isolation of landing ports or other factors, it consistently arouses strong opposition among harvesters, particularly with regard to the issue of exvessel price determination.

The statistical information gathered for this study is evaluated at two levels of industry detail. First, data are compiled for the Alaska seafood processing sector as a whole without regard to differences which separate the individual industries of the sector. The structural parameters for this level of detail will be discussed first. Second, production data are organized by individual industries in order that the economic structure of these entities can be determined. The latter level of detail is the more theoretically correct for assessing competitive conditions, particularly on the buying side of the market. The individual industry analysis will follow the sectorial analysis.

Structural Parameters of the Alaska Seafood Processing Sector

This section will present measures of market structure which are applicable to the entire Alaska seafood processing sector (as opposed to the individual industries which together comprise the processing sector). The primary characteristic of this information is that it lacks specificity with regard to species and process forms.

Geographic Distribution of Production Facilities

Coastal Alaska has seafood processing establishments from the extreme southeast to the Arctic. As shown in Tables 4 and 5, the present day distribution of production facilities has changed significantly since the pre-statehood period. The number of production establishments in Southeast Alaska has declined to less than half, falling from 103 to 47. The number of companies declined from 81 to 44 and the prevalence of multiplant companies fell as well. Yakutat is the only community experiencing growth in both plants and companies and all of the latter are single-plant entities. During Period 1 (1956 to 1958), six establishments failed to report specific location.

Southcentral Alaska, in contrast, has experienced significant growth since statehood in both plants and companies, regionwide and in each community (or landing port). The greatest growth occurred in Cook Inlet, which gained 31 plants and 26 companies. Kodiak gained 15 plants and five companies. The occurrence of multiplant companies has increased significantly, especially in Cook Inlet and Kodiak. Chignik experienced the greatest proportional growth, a four-fold increase in both the number of plants and companies.

Western Alaska experienced a net decline in companies from 46 to 39, but gained a net of five producing establishments. This resulted in an increase in the number of multiplant companies. Within this vast region, the Aleutians gained 18 plants (13 of which are floaters) and ten companies. Bristol Bay, on the other hand, lost nine plants and eight companies.

TABLE 4

ALASKA SEAFOOD PROCESSING PRODUCTION FACILITIES, REGIONAL SUMMARY BY PERIOD

	Period 2[1]		Change from Period 1[2]		Ratio of Plants to Companies	
	Plants	Companies	Plants	Companies	Period 1	Period 2
Southeastern	47	44	-56	-37	1.27	1.07
Central	144	105	+65	+38	1.18	1.37
Western	54	39	+ 5	- 7	1.07	1.38
Bristol Bay	30	28	- 9	- 8	1.08	1.07
AYK[3]	47	45	+34	+34	1.18	1.04

Source: Compiled from data provided by the Alaska Department of Fish and Game.

[1]1973 to 1975.

[2]1956 to 1958.

[3]Arctic-Yukon-Kuskokwim.

Note: For areas included in each region see Table 5 and also Alaska Department of Fish and Game leaflet area map.

TABLE 5

GEOGRAPHIC DISTRIBUTION OF SEAFOOD PROCESSING PLANTS AND COMPANIES BY PERIOD

	Period 1[1]					Period 2[2]				
Area	Shore Plants	Floating Plants	Total Plants	Total Companies	Plants/ Companies	Shore Plants	Floating Plants	Total Plants	Total Companies	Plants/ Companies
Ketchikan	25	7	32	28		11	2	13	12	
Petersburg/ Wrangell	22	1	23	22		10	2	12	12	
Sitka	22	1	23	19		6		6	6	
Juneau	18		18	17		11	1	12	11	
Yakutat		1	1	1		3	1	4	4	
Unidentified	1	5	6	6						
Total Southeast	88	15	103	81	1.27	41	6	47	44	1.07
Prince William Sound	16	5	21	21		20	13	33	32	
Cook Inlet	20	2	22	21		47	6	53	47	
Kodiak	18	5	23	22		27	11	38	27	
Chignik	2		2	2		7	1	8	8	
S. Peninsula	7	3	10	8		9	3	12	8	
Unidentified		1	1	1						
Total Central	63	16	79	67	1.18	110	34	144	105	1.37
Aleutians	2	2	4	4		7	15	22	14	
N. Peninsula	1	2	3	3		2		2	2	
Bristol Bay	29	10	39	36		24	6	30	28	
Unidentified		3	3	3						
Total Western	32	17	49	46	1.07	33	21	54	39	1.38
Kuskokwim	1		1	1		11	3	14	14	
Yukon	12		12	10		28	2	30	29	
Norton Sound						2		2	2	
Arctic						1		1	1	
Total AYK	13		13	11	1.18	42	5	47	45	1.04

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1] 1956 to 1958.

[2] 1973 to 1975.

The Arctic-Yukon-Kuskokwim (AYK) region has enjoyed significant growth since statehood. This region has gained 34 plants and 34 companies, causing multiplant companies to decrease slightly in relative importance. Both the Yukon and Kuskokwim districts are characterized by small plants and companies.

As might be expected, the distribution of production facilities have followed the geographic distribution of harvestable surpluses in important stocks (Table 6). In particular, Southeast Alaska (with the exception of Yakutat) and Bristol Bay have lost production facilities, presumably due to the decline in salmon stocks. Central Alaska and the Aleutians have grown rapidly as a result of exploitation of previously underutilized or unutilized shellfish stocks.

Another relevant aspect of geographic distribution refers to the degree to which companies specialize geographically and whether this tendency is changing. As shown in Table 7, geographic specialization is increasing, both in terms of number of companies producing in multiple regions (general areas) and multiple communities (specific areas). The shift in effort to, and the location of surplus shellfish stocks in Central and Western Alaska may explain the increased geographic specialization, as these regions are larger and more remote.

Tables 8 and 9 show the size distribution of plants and companies respectively by region and by period. Surprisingly, Southeast Alaska was the only region gaining plants in the largest size categories though it lost plants overall. Small plants and companies gained in Central and AYK and declined in number in Western Alaska.

Aggregate Concentration

Aggregate concentration refers to the size distribution of all seafood production among companies (or plants), without regard to species or process form categories. The economic implications of high aggregate concentration are uncertain. First, high aggregate concentration in the economy or its major sectors does not necessarily imply high concentration in individual industries (e.g., frozen halibut, canned salmon, etc.). Second, high aggregate concentration tends to be associated with firms that are large in relation to the individual markets in which they operate; i.e., it tends to be associated with dominant firms (Gort 1962). The latter, in turn, are often associated with "price-leadership" pricing behavior by firms in oligopolistically structured industries. Third, high aggregate concentration is positively associated with large firm size and diversification, both of which can be sources of market power (Gort 1962; Orth 1970; Scherer 1970). Fourth, there is evidence suggesting that large firms tend to be more progressive than smaller firms, making them more dynamic competitors (Scherer 1970).

The applicability of these generalizations to the Alaska seafood processing sector is not necessarily straightforward. For this reason, and because a thorough analysis of these issues is beyond the scope of this study, this report will be devoted to a presentation of the factual material gathered. The latter is of interest because it describes the organization of plants and companies within the sector and how organization has changed since statehood.

TABLE 6

HARVEST OF FINFISH AND SHELLFISH BY REGION
(In Pounds)

Year	Southeast		Central		Western	
	Finfish	Shellfish	Finfish	Shellfish	Finfish	Shellfish
1956[1]						
1957[1]						
1958	203,080,267	8,162,231	112,755,451	12,658,688	40,573,110	...
1973	83,912,653	6,564,383	88,120,326	205,035,501	14,411,069	53,330,491
1974	82,349,821	6,597,059	70,922,075	191,149,919	17,324,798	73,932,112
1975	53,736,206	5,700,428	90,082,954	165,271,442	32,030,913	75,532,011
1976	73,188,742	6,291,926	151,257,574	202,041,511	57,712,104	108,716,699

Year	Bristol Bay[3]		AYK		Total	
	Finfish	Shellfish	Finfish	Shellfish	Finfish	Shellfish
1956[1]					410,432,000	14,286,000
1957[1]					349,427,000	16,009,000
1958					356,408,828	20,820,919
1973	11,676,416[2]	...	9,670,068[2]	...	196,114,116	264,930,375
1974	14,540,168[2]	...	16,366,275[2]	...	186,962,969	271,679,090
1975	29,629,462[2]	...	15,321,119[2]	...	191,171,192	246,503,881
1976	48,447,741[2]	...	11,302,373[2]	...	293,460,793	317,050,136

Source: Alaska Department of Fish and Game Statistical Leaflets.

[1]Region breakdown not available.

[2]Figures available for salmon only.

[3]Included in Western.

TABLE 7

COMPANY FREQUENCY DISTRIBUTION
BY NUMBER OF GENERAL REGIONS AND SPECIFIC AREAS
BY PERIOD

Number of General Regions[1]	Number of Companies Period 1[2]	Period 2[3]	Change
1	150	190	40
2	17	14	-3
3	7	5	-2
Number of Specific Areas[4]			
1	140	184	44
2	19	13	-6
3	7	6	-1
4	5	4	-1
5	3	0	-3
6	0	1	1
7	0	1	1

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Regions are Southeastern, Central, Western, and Arctic-Yukon-Kuskokwim (AYK)

[2]1956 to 1958.

[3]1973 to 1975.

[4]Specific areas are communities or landing ports within regions (see Table 5 for specific area detail).

NOTE: Sample interpretation: 150 companies in Period 1, and 190 in Period 2 operated in only one general area; 17 companies in Period 1, and 14 in Period 2 operated in two general areas, etc.

TABLE 8

PLANT SIZE DISTRIBUTION BY REGION AND PERIOD

	Southeast			Central		
Quantity Produced[1]	Period 1[2]	Period 2[3]	Change	Period 1	Period 2	Change
1 - 50,000	18	12	-6	23	49	26
50,001 - 150,000	16	6	-10	9	26	17
150,001 - 350,000	12	3	-9	8	15	7
350,001 - 750,000	11	7	-4	7	15	8
750,001 - 1,550,000	12	3	-9	8	10	2
1,550,001 - 3,150,000	14	7	-7	15	15	0
3,150,001 - 6,350,000	17	6	-11	8	10	2
6,350,001 - 12,750,000	0	2	2	1	1	0
> 12,750,000	0	1	1	0	0	0

	Western			AYK		
Quantity Produced[1]	Period 1	Period 2	Change	Period 1	Period 2	Change
1 - 50,000	22	13	-9	8	26	18
50,001 - 150,000	6	9	3	3	6	3
150,001 - 350,000	3	3	0	2	2	0
350,001 - 750,000	6	9	3	0	8	8
750,001 - 1,550,000	4	10	6	0	5	5
1,550,001 - 3,150,000	4	9	5	0	0	0
3,150,001 - 6,350,000	4	1	-3	0	0	0
6,350,001 - 12,750,000	0	0	0	0	0	0
> 12,750,000	0	0	0	0	0	0

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Pounds of finished product-weight equivalents.

[2]1956 to 1958.

[3]1973 to 1975.

TABLE 9

COMPANY SIZE DISTRIBUTION BY REGION AND PERIOD

Quantity Produced[1]	Southeast Period 1[2]	Southeast Period 2[3]	Southeast Change	Central Period 1	Central Period 2	Central Change
1 - 50,000	13	11	-2	22	47	25
50,001 - 150,000	9	6	-3	8	19	11
150,001 - 350,000	12	3	-9	6	12	6
350,001 - 750,000	9	7	-2	6	3	-3
750,001 - 1,550,000	10	2	-8	4	6	2
1,550,001 - 3,150,000	9	7	-2	11	6	-5
3,150,001 - 6,350,000	15	5	-10	8	7	-1
6,350,001 - 12,750,000	3	2	-1	2	5	3
> 12,750,000	0	1	1	0	0	0

Quantity Produced[1]	Western Period 1	Western Period 2	Western Change	AYK Period 1	AYK Period 2	AYK Change
1 - 50,000	22	11	-11	7	24	17
50,001 - 150,000	6	6	0	2	7	5
150,001 - 350,000	3	2	-1	2	2	0
350,001 - 750,000	6	4	-2	0	6	6
750,001 - 1,550,000	3	4	1	0	6	6
1,550,001 - 3,150,000	2	8	6	0	0	0
3,150,001 - 6,350,000	3	4	1	0	0	0
6,350,001 - 12,750,000	1	0	-1	0	0	0
> 12,750,000	0	0	0	0	0	0

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Pounds of finished product-weight equivalents.

[2]1956 to 1958.

[3]1973 to 1975.

During Period 1 (1956 to 1958) there were 227 plants and 174 companies reporting some production. Of these companies, 145 operated only one plant, 17 companies operated two plants, six companies had three plants, three had four plants, and one each had five, six, and seven plants. As shown in Table 10, the number of one plant companies in Period 2 was 179. Period 2 is otherwise quite comparable to Period 1 except that there are two companies having 10 and 11 plants, respectively. The mean number of plants in Period 1 was 1.305 and in Period 2 it was 1.349.

Table 11 shows the size distribution of plants and companies for Period 1 and Period 2. In Period 1, 28.6 percent of plants produced less than 50,000 pounds of product (meat weight equivalents) and 50.7 percent produced less than 350,000 pounds. In Period 2, 35.5 percent and 57.1 percent of plants produced less than 50,000 and 350,000 pounds, respectively. In Period 1, 28.2 percent of plants produced more than 1.5 million pounds and only 18.4 percent of plants produced more than this amount in Period 2. The middle range, from 350,000 pounds to 1.5 million pounds held 21.1 percent of plants in Period 1 and 24.5 percent in Period 2. The average production of plants was approximately 1.2 million pounds in Period 1 and 0.9 million pounds in Period 2.

The distribution of companies by production is similar to that for plants. This is not surprising given that 83 percent of companies in Period 1 and 86 percent in Period 2 were single-plant companies. In Period 1, 32.8 percent produced less than 350,000 pounds. In Period 2, these were 41.1 percent and 65.1 percent respectively. There were 25.3 percent of all companies producing more than 1.5 million pounds in Period 1 and 18.2 percent in Period 2. In period 1, 21.3 percent of companies produced between 350,000 pounds and 1.5 million pounds and 16.7 percent fell in this range in Period 2. The average production of companies was approximately 1.5 and 1.2 million pounds in Periods 1 and 2, respectively.

In addition to the number and percent of plants and companies in each size category, it is useful to know the cumulative control over production accounted for by plants and companies of different sizes. That is, in addition to knowing the number of companies in a size category, one should also know the percent of <u>total</u> production controlled by those companies. This information is obtained from Tables 12 and 13 and Figures 4 and 5.

Roughly half of all plants produced 97 percent of total production in Period 1 and 98 percent in Period 2. In Period 1 the 113 out of 227 plants produced three percent of total output and in Period 2 this fell to two percent for 141 out of 282 plants. The level of aggregate company concentration is even higher due to the significance of multiplant companies. There were 29 such companies in Period 1 and 30 in Period 2. The top half of companies (87 out of 174) had 98 percent of total seafood production in Period 1 and 99 percent (104 out of 209) in Period 2. The largest ten percent (17 and 20 companies, respectively) in Period 1 had 55 percent of total product and 68 percent in Period 2. The top 25

TABLE 10

NUMBER OF ALASKA SEAFOOD PLANTS OPERATED BY COMPANIES BY PERIOD

Number of Plants	Number of Companies: Period 1[1]	Period 2[2]	Change
1	145	179	+34
2	17	16	-1
3	6	5	-1
4	3	2	-1
5	1	3	+2
6	1	2	+1
7	1	0	-1
8	0	0	0
9	0	0	0
10	0	1	+1
11	0	1	+1
Total	174	209	+35
Mean	1.305	1.349	-

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]1956 to 1958.

[2]1973 to 1975.

TABLE 11

SIZE DISTRIBUTION OF ALASKA SEAFOOD PLANTS AND COMPANIES BY PERIOD

	PLANTS					COMPANIES				
	Period 1[1]		Period 2[2]			Period 1		Period 2		
Production[3]	Number	Cum %	Number	Cum %	Change	Number	Cum %	Number	Cum %	Change
1 - 50,000	65	28.6	100	35.5	+35	57	32.8	86	41.1	+29
50,001 - 150,000	30	39.6	42	50.4	+12	20	44.3	35	57.9	+15
150,001 - 350,000	20	50.7	19	57.1	- 1	16	52.4	15	65.1	- 1
350,001 - 750,000	20	59.5	39	70.9	+19	18	63.8	20	71.6	+ 2
750,001 - 1,550,000	28	71.8	30	81.6	+ 2	19	74.7	15	81.8	- 4
1,550,001 - 3,150,000	34	86.8	31	92.6	- 3	15	83.3	16	89.5	+ 1
3,150,001 - 6,350,000	29	99.6	17	98.6	-12	22	96.0	12	95.2	-10
6,350,001 - 12,550,000	1	100.0	3	96.6	+ 2	3	97.7	7	98.6	+ 4
12,550,001 - 25,550,000	0	100.0	1	100.1	+ 1	4	100.0	2	99.5	- 2
25,550,001 - 51,150,000	0	100.0	0	100.1	0	0	100.0	2	99.5	- 1
Total	227		282		+55	174		209		+35
Average Production	1,161,375		857,663			1,515,127		1,157,230		

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]1956 to 1958.

[2]1973 to 1975.

[3]Pounds of meat-weight equivalents.

TABLE 12

DISTRIBUTION OF PRODUCTION OF ALASKA SEAFOOD PROCESSING PLANTS BY PERCENT CATEGORY AND PERIOD

Percent of Largest Plants	Percent of Total Production			Number of Plants	
	Period 1[1]	Period 2[2]	Change	Period 1	Period
5	23	36	+13	11	14
10	41	54	+13	22	28
15	56	67	+11	34	42
20	67	77	+10	45	56
25	75	83	+8	56	70
30	83	88	+5	68	84
35	88	92	+4	79	98
40	92	94	+2	90	112
45	95	97	+2	102	126
50	97	98	+1	113	141
55	98	99	+1	124	155
60	99	99[3]	0	136	169
65	99[3]	99[3]	0	147	183
70	100[3]	100[3]	0	158	197
75	100[3]	100[3]	0	170	211
80	100[3]	100[3]	0	181	225
85	100[3]	100[3]	0	192	239
90	100[3]	100[3]	0	204	253
95	100[3]	100[3]	0	215	267
100	100	100	0	227	282

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]1956 to 1958.

[2]1973 to 1975.

[3]Rounded.

TABLE 13

DISTRIBUTION OF PRODUCTION OF ALASKA SEAFOOD PROCESSING COMPANIES BY PERCENT CATEGORY AND PERIOD

Percent of Largest Companies	Percent of Total Production			Number of Companies	
	Period 1[1]	Period 2[2]	Change	Period 1	Period
5	38	49	+11	8	10
10	55	68	+13	17	20
15	69	80	+11	26	31
20	78	87	+9	34	41
25	85	92	+7	43	52
30	90	95	+5	52	62
35	93	97	+4	60	73
40	96	98	+2	69	83
45	97	99	+2	78	94
50	98	99[3]	+1	87	104
55	99	99[3]	0	95	114
60	99[3]	100[3]	+1	104	125
65	100[3]	100[3]	0	113	135
70	100[3]	100[3]	0	121	146
75	100[3]	100[3]	0	130	156
80	100[3]	100[3]	0	139	167
85	100[3]	100[3]	0	147	177
90	100[3]	100[3]	0	156	188
95	100[3]	100[3]	0	165	198
100	100	100	0	174	209

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]1956 to 1958.

[2]1973 to 1975.

[3]Rounded.

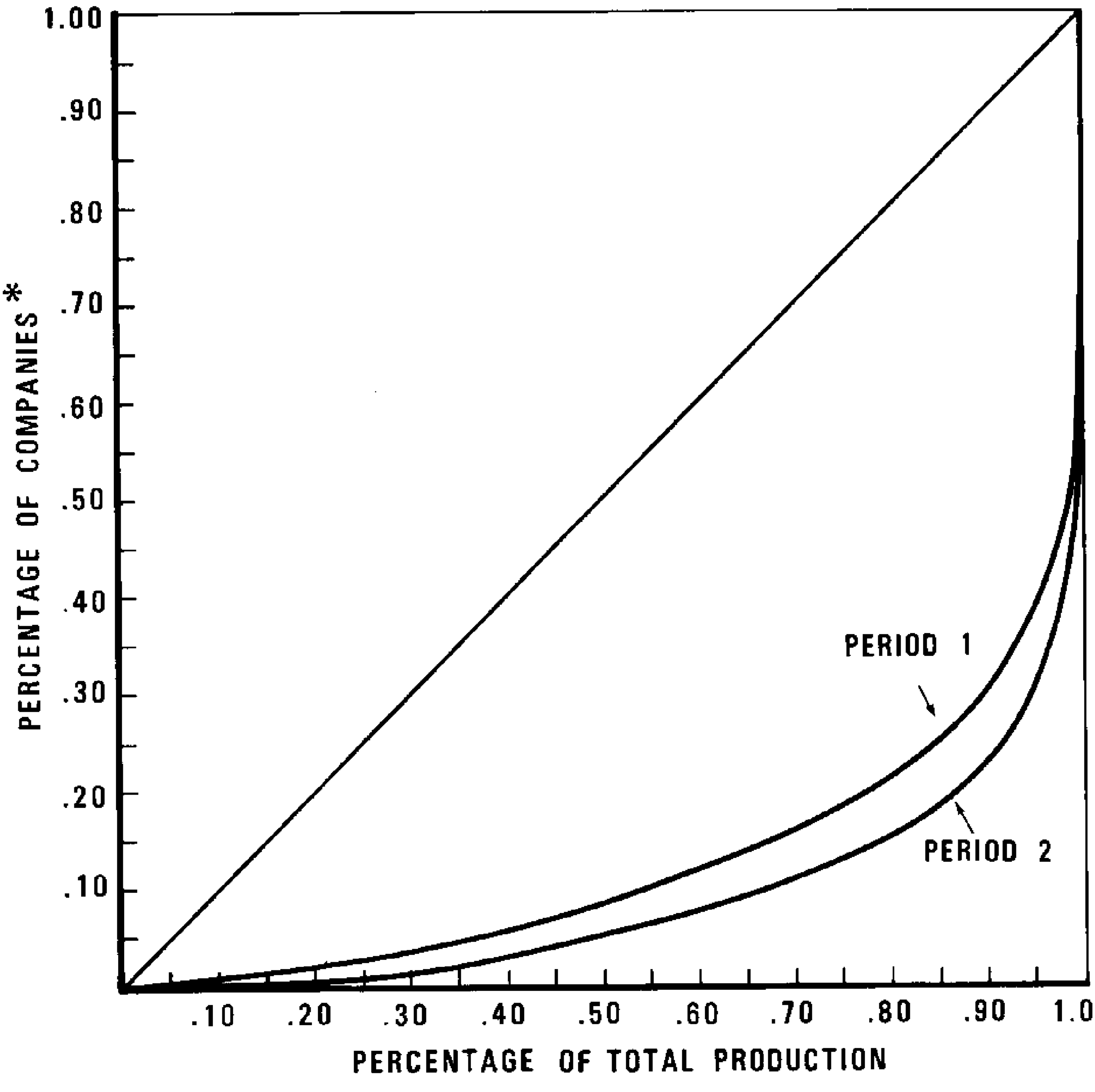

FIGURE 4. LORENZ CURVES FOR ALASKA SEAFOOD PROCESSING PLANTS

*Cumulative from the largest plants

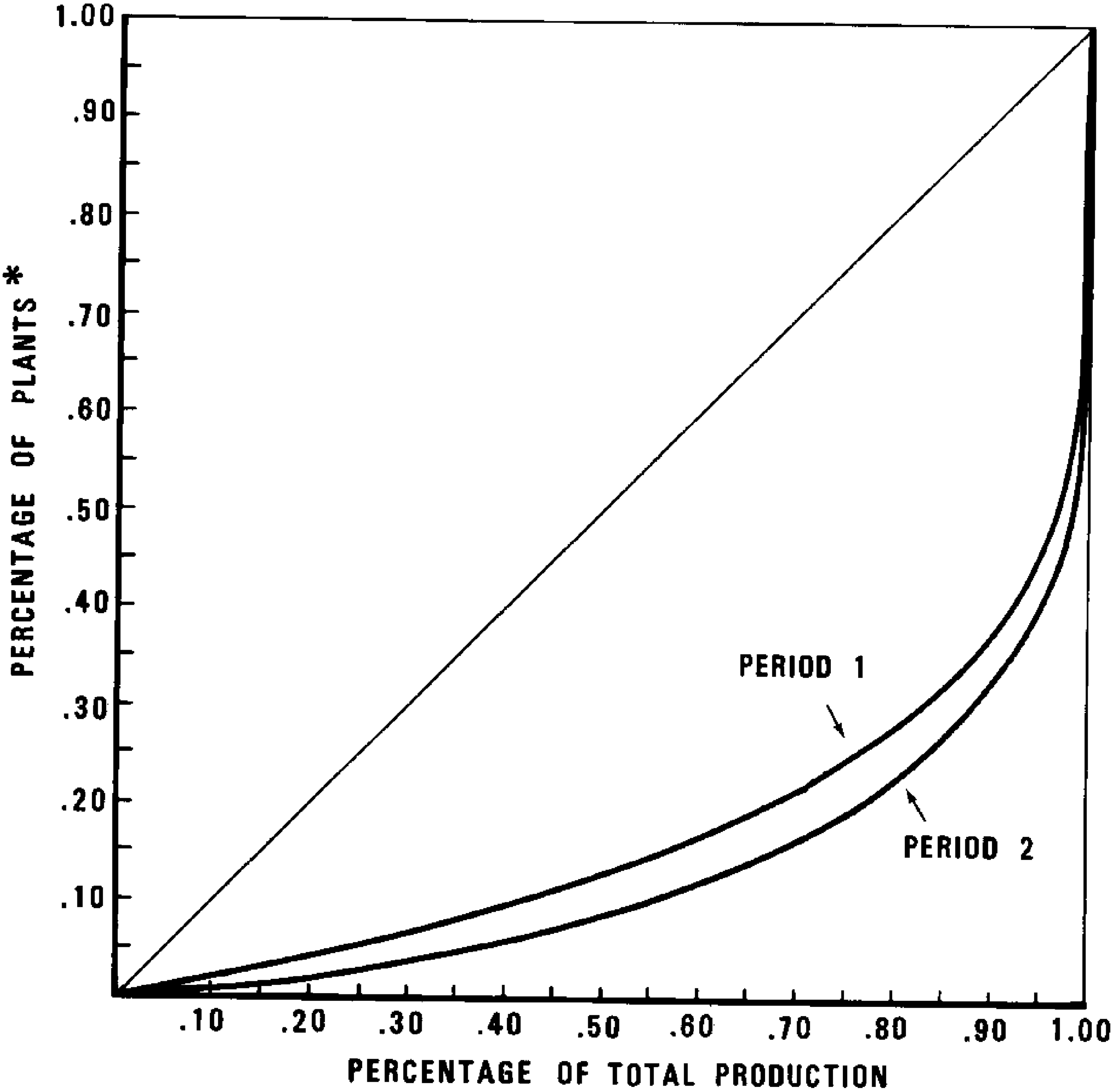

FIGURE 5. LORENZ CURVES FOR ALASKA SEAFOOD PROCESSING COMPANIES

*Cumulative from the largest companies

companies controlled two-thirds and three-fourths of total production in Period 1 and Period 2 respectively (Table 14). Thus not only is overall concentration in the Alaska seafood processing sector high, it has increased significantly since statehood.

Diversification

Another structural characteristic of an industry is the degree to which the plants and companies are diversified. Diversification refers to the production of products by a plant or firm which are sold in more than one industry. In principle, a diversified plant or firm is one having multiple product lines. In practice, the distinction among product lines (their differences and similarities) is often difficult to determine objectively. This is partially due to the fact that the degree of difference is often dependent upon the intended application of a product to a particular end use.[2] These complications require decision rules when attempts are made to specify (quantify) the degree of diversification of plants and companies.

For seafood processing plants and companies, the obvious methods for measuring the degree of diversification are to count the number of species processed, the number of processing methods (canning, curing, freezing, fresh), or the number of product forms (whole, fillets and steaks, sections, claws, etc.). None of these, of course, are faultless methods. The most appealing criterion from a technological standpoint is the number of processing methods. However, its use would result in understatement of diversification in that a particular method (e.g., freezing) can apply to many species (e.g., salmon, crab, shrimp) and product forms (e.g., whole, fillets, sections) that are not close substitutes.

Tables 15 through 17 show diversification of Alaska seafood processing plants and companies by each of the three measures employed. They are consistent in showing that diversification of both plants and companies has increased since statehood and that, in general, plants are nearly as diversified as companies. This suggests that, in general, company diversification is achieved via plant diversity rather than the acquisition by multiplant companies of specialized plants producing in different specialized markets. In addition, since among the more diversified plants the number of plants is greater than the number of diversified companies, one can infer that the more diversified plants are owned by multiplant companies. For the single species (or process or product) category, the number of plants also exceeds the number of companies. The inference here is that not only do many single-plant companies specialize, but a number of multiplant companies hold specialized plants as well, and that their plant holdings overall are targeted toward specific species.

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[2]For example, consumers might view canned salmon from sockeye, pink, and chum species as close substitutes for salmon cakes but they might have a distinct species preference if the salmon is to go into an exotic salad, where color is important.

TABLE 14

AGGREGATE CONCENTRATION IN THE ALASKA SEAFOOD PROCESSING SECTOR BY PLANTS AND COMPANIES AND BY PERIOD

	Concentration Ratios[1]					
	Plants			Companies		
The Top	Period 1[2]	Period 2[3]	Change	Period 1	Period 2	Change
10	.21	.29	+.08	.43	.49	+.06
25	.45	.50	+.05	.67	.74	+.07
50	.71	.73	+.02	.89	.91	+.02
100	.95	.92	+.03	.99	.99	0
200	1.00[4]	1.00[4]	0	1.00	1.00[4]	0

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Each concentration ratio is the production (in meat-weight equivalents) of a given number of top firms over the total production in the Alaska seafood processing sector; when multiplied by 100 it is the percent control of total production by these firms.

[2]1956 to 1958.

[3]1973 to 1975.

[4]Rounded; 174 companies and 227 plants in Period 1, and 209 companies and 282 plants in Period 2.

TABLE 15

DIVERSIFICATION OF ALASKA SEAFOOD PROCESSING PLANTS AND COMPANIES AS MEASURED BY THE NUMBER OF SPECIES HANDLED AND BY PERIOD

Number of	Plants			Companies		
Species Handled[1]	Period 1[2]	Period 2[3]	Change	Period 1	Period 2	Chang
1	181	199	+18	131	142	+11
2	31	39	+ 8	30	38	- 2
3	13	22	+ 9	11	16	+ 5
4	0	15	+15	1	14	+13
5	1	7	+ 6	1	9	+ 8
Average	1.270	1.553		1.339	1.660	

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Species are salmon, crab, shrimp, halibut, and herring.

[2]1965 to 1958.

[3]1973 to 1975.

TABLE 16

DIVERSIFICATION OF ALASKA SEAFOOD PROCESSING PLANTS AND COMPANIES AS MEASURED BY THE NUMBER OF PROCESSES AND BY PERIOD

Number of Processes[1]	Plants			Companies		
	Period 1[2]	Period 2[3]	Change	Period 1	Period 2	Change
1	164	151	-13	116	108	-08
2	52	73	+21	45	52	+07
3	9	51	+42	9	39	+30
4	0	7	+07	2	8	+06
5	2	0	-02	2	2	0
Average	1.344	1.695		1.443	1.775	

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Processes are fresh, frozen, canned, smoked in can, smoked, mild cure, salted, and reduction.

[2]1956 to 1958.

[3]1973 to 1975.

TABLE 17

DIVERSIFICATION OF ALASKA SEAFOOD PROCESSING PLANTS AND COMPANIES AS MEASURED BY THE NUMBER OF PRODUCTS AND BY PERIOD

Number of Products[1]	Plants			Companies		
	Period 1[2]	Period 2[3]	Change	Period 1	Period 2	Change
1	170	113	-57	120	87	-33
2	50	98	+48	44	73	+29
3	2	36	+34	5	22	+17
4	4	23	+19	4	11	+ 7
5	0	5	+ 5	0	4	+ 4
6	0	4	+ 4	0	8	+ 8
7	1	2	+ 1	1	1	0
8	0	0	0	0	1	+ 1
9	0	0	0	0	1	+ 1
10	0	0	0	0	1	+ 1
Average	1.317	2.064		1.414	2.129	

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Products are whole/dressed, cheeks/fletches, sections (crab) or tails (shrimp), meats (crab or salmon in can), bait, roe (eggs), bait roe, roe (herring) on kelp, oil, meal, fillets/steaks/strips, crab claws.

[2]1956 to 1958.

[3]1973 to 1975.

The apparent trend toward increasing diversity since statehood can probably be explained by four factors. First, there would appear to be a natural desire by plant owners to increase plant utilization through expansion into areas that are counter-seasonal to their primary product (or species or process). Second, when high-valued resources become depleted or reach a low in their cycle, there is economic pressure to expand sales by entering other production activities. Third, technological change and changing marketing conditions have encouraged companies to expand into new areas. Fourth, foreign investment has stimulated diversity by providing capital for expansion and assured markets.

Turnover

One way to judge the long-run implications of economic concentration in a sector of the economy (or more narrowly defined individual industry) is to attempt to identify the degree to which companies are entrenched in dominant positions through time. A high degree of turnover of companies within a sector or industry suggest that entrenchment is not an important structural characteristic.

Turnover is defined as the disappearance from a sector or industry altogether or from the top echelon of firms in the sector or industry. Conducting a test for the presence or absence of turnover is a method of assessing whether the competitive environment is dynamic or whether it has settled into a static condition characterized by entrenched positions for the dominant firms.

For this study, company turnover was evaluated both in terms of survivorability and change in market share.[3] The screening of the data for identifying company turnover is complicated by the inability to follow identity in those cases where a company has changed its name between Period 1 and Period 2. To the extent that this has occurred, the turnover measures will overstate actual turnover to an undetermined degree. In those cases where a firm is dissolved or acquired by another company, it disappears as an ownership entity and is properly treated in the turnover analysis.

Of the 152 companies whose production in Period 1 was greater than their production in Period 2, 139 had no production in Period 2. Similarly, of the 196 companies having greater production in Period 2 than Period 1, 174 had no production in Period 1. There remain, therefore, 35 companies which produced in both periods. Table 18 shows the change in production from Period 1 to Period 2 for these 35 companies. The majority of companies producing in both periods grew in absolute size, but 13 declined. The size distribution of these 35 companies in both periods is shown in Table 19.

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[3]Market share is defined here as the share of total production of the entire Alaska seafood processing sector.

TABLE 18

DISTRIBUTION OF COMPANIES PRODUCING IN BOTH PERIODS
GROUPED BY THE SIZE OF THE INCREASE OR DECREASE IN PRODUCTION

Change in Production from Period 1[1] to Period 2[2]	Number of Plants	
Increase	22	
Over 100 percent		13
50-100 percent		4
25-50 percent		4
0-25 percent		1
Decrease	13	
0-25 percent		6
25-50 percent		3
50-100 percent		4
Total	35	

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]1956 to 1958.

[2]1973 to 1975.

TABLE 19

SIZE DISTRIBUTION OF COMPANIES PRODUCING
IN BOTH PERIODS

Quantity Produced[1]	Number of Companies Period 1[2]	Period 2[3]	Change
1 - 50,000	8	6	-2
50,001 - 150,000	5	2	-3
150,001 - 350,000	2	2	0
350,001 - 750,000	3	2	-1
750,001 - 1,550,000	3	4	+1
1,550,001 - 3,150,000	6	7	+1
3,150,001 - 6,350,000	5	8	+3
6,350,001 - 12,750,000	1	3	+2
> 12,750,000	2	1	-1

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Pounds of meat weight equivalents.

[2]1956 to 1958.

[3]1973 to 1975.

Table 20 shows by rank category the number of compaines with zero production in the opposite period. Of the top five companies in Period 1, three were not in existence in Period 2; of those ranked 6 to 15, seven did not produce in Period 2. Four of the top five companies in Period 2 did not exist in Period 1; those ranked 6 to 15 in Period 2 contained four who did not produce in Period 1. Cumulatively, the very largest firms in Period 1 (ten of the top 15) did not survive to Period 2 and eight of the top 15 in Period 2 did not exist in Period 1.

To summarize, turnover among Alaska seafood processing firms has been quite high since statehood. Of the 174 companies operating in Period 1 and 209 in Period 2, only 35 operated in both periods under the same company identity. Of the industry leaders in Period 1, a significant number did not operate in Period 2 (three of top five and ten of top 15). Similarly, of those holding dominant positions in Period 2, a majority (four out of five and eight of top 15) did not produce in Period 1.

Due to the inability to consistently trace individual company identities over the 20 years covered by this analysis, the data base was taken at face value with respect to the identity of reporting plants and companies. This loss of detail means that the measures of turnover employed are undoubtedly biased upward. The overall impression of high turnover is probably sound nonetheless, with the exception of a very few firms that have been able to maintain high ranking positions in both periods. Only three companies were ranked among the top 15 companies in both periods. The next largest ten companies in both periods were not represented at all in the same group in the opposite period. Cumulatively, then, only three companies were represented on the list of the top 20 firms in both periods and each of these was within the largest ten in both periods.

Vertical Integration

No direct inferences concerning the extent of vertical integration were possible from the secondary data resources available to this study. Questions concerning vertical integration were included in an industry survey sent to roughly the largest 50 firms in 1976. Of these firms, 19 completed or partially completed the survey form. An additional 11 said they desired to respond but had not done so by August 1, 1978, at which time the survey had to be closed.[4] Survey results, compiled to avoid disclosure of individual-firm information, are presented in Appendix III of Volume I.

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[4]It was unfortunate that the survey was mailed to processors at the beginning of their busy season, but this was unavoidable since the researchers experienced extensive delays in efforts to work with industry executives toward a meaningful and mutually acceptable survey format. In addition, a considerable amount of confusion was created when the same research team set out to collect processing capacity and marketing data (for use by the North Pacific Fishery Management Council) coincident with initial negotiations over the survey effort for this study.

TABLE 20

OPPOSITE PERIOD PRODUCTION BY MARKET SHARE RANK CATEGORY

Company Rank Period 1[1]	Number of Companies with Zero Production in Period 2[2]	Company Rank Period 2	Number of Companies with Zero Production in Period 1
1-5	3	1-5	4
6-15	7	6-15	4
16-35	16	16-35	9
36-75	29	36-75	33
76-155	68	76-155	73
156-315	16	156-315	51

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]1956 to 1958.

[2]1973 to 1975.

[3]Total number of companies in Period 1 is 174.

[4]Total number of companies in Period 2 is 209.

Two characteristics of the respondents can be mentioned. First, several of the largest firms cooperated with the survey (including the largest firm). Second, the firms with the most extensive apparent ownership interties with other seafood processors refused to cooperate with the survey.

Backward Vertical Integration. Backward integration by a company refers to the development of a capability to provide its own sources of supply, either through acquisition or construction. In the seafood processing industry, a topic of interest is the ownership by processing firms of vessels or the use of other techniques (e.g., providing supplies or credit) to assure supplies of raw fish. Of the 19 survey respondents, nine indicated that they did own vessels; Table 21 shows the number of vessels owned by each of these respondents and the species fished by these vessels.

Thirteen respondents felt that, in general, the practice of vessel ownership had increased over the last ten years; only one believed that this practice had decreased. Four respondents felt that decreases had occurred in the salmon fisheries; two felt that it had increased in crab.

The practice of advancing money, gear, or supplies is common and may be a tacit form of backward integration. Sixteen respondents indicated that they did make advances and nine indicated an interest charge. Most respondents believed this practice has not changed over the past decade while five believed it had decreased; only three felt that it had increased.

For those companies who responded to this survey, vertical integration is an important, but not universal, form of organizational practice. This practice appears to be declining in importance, particularly in the salmon fishery where the imposition of limited entry has created greater economic independence among fishermen. It is uncertain how representative these survey results are of the vertical-integration practices of the industry as a whole.

Forward Vertical Integration. This form of integration exists when companies acquire capability in the distribution chain of the goods they produce. Four of the 19 respondents did own an interest in brokerage, wholesale or retail seafood businesses. Only one respondent believed this practice of ownership of distributors has decreased, four that it has increased, five that it had not changed, and six did not respond. The three remaining responses consisted of narrative to the effect that nearly all large processors have in-house brokerage or sales departments (apparently as opposed to holding an interest in a separate company) and that this structural feature is increasingly evident.

Other Company-Specific Information

This section will briefly cover topics which are presented in detail in Appendix III of Volume I. These topics are: Company financial characteristics, transportation of raw and processed products, domestic sales

TABLE 21

EXTENT OF VESSEL OWNERSHIP BY "YES" RESPONDENTS

Company Designator	Number of Vessels Owned	Species Fished
1	2	Crab
2	2	Salmon
3	3	Crab
4	3	Salmon
5	5	Crab, Shrimp
6	5	Crab[1]
7	10	Salmon
8	40	Crab, Salmon[2]
9	90	Salmon[3]

Source: Company survey.

[1]Company "6" also owned 15 salmon vessels in Washington.

[2]Company "8" also owned 30 salmon and crab vessels in Washington and 6 shrimp and scallop vessels in remainder of U.S.

[3]Company "9" reduced vessels to approximately 30 in 1977.

practices and trends, international business arrangements, and the entry or exit decisions of companies.

Company Financial Characteristics (Re: Volume I, Appendix III; Part I, 1 through 5, and Part II)

All respondents indicated a high degree of specialization in the seafood business. Fourteen of the 18 companies who responded to this question had 100 percent of their sales in fish products, three others had between 75 and 100 percent and one between 50 and 75 percent. This specialization in seafood contrasts with the high level and increasing extent of diversification within the seafood business as shown in an earlier section of this chapter. Five of the respondent companies indicated that they owned plants in other states, but Alaska is the primary production area for 17 of those responding. Of the 17 firms indicating their asset and sales size range, 12 had assets (less merchandise inventory) of greater than $10 million; and 16 indicated sales in excess of $1 million, eight had sales in excess of $5 million, and seven had sales of more than $10 million. From this information, it would appear that seafood processors generally have sales-to-asset ratios greater than one. Eight of the 14 companies providing information on their debt-equity structure showed equity-to-assets in excess of 50 percent and seven of these in excess of 75 percent. Four were highly leveraged at ratios of less than 25 percent and two had ratios between 25 and 80 percent. It is uncertain whether the five non-respondents were also highly leveraged as might be assumed. Thirteen of the respondents are private, closely-held corporations, only one is publicly traded, one is a partnership and four are wholly-owned subsidiaries of other companies. Five of 19 companies indicated some ownership by other seafood processing companies, and five companies indicated that they owned from 50 to 100 percent of another seafood processor.

Transportation (Re: Volume I, Appendix III; Part IV, 1a through 1c)

The most common method for transporting raw fish to processors is direct delivery by fishing vessels. This is true for all species except salmon when company-owned or chartered tenders are the most frequently reported method. Tendering is also a close second in herring but is used seldom for halibut. There was no reported use of tendering in the shellfish fisheries. It is tempting to conclude that aside from depressed stock conditions and the accompanying regulatory constraints (e.g., time and area closures) direct delivery is the more efficient method of transporting raw fish. Such judgements cannot be made, of course, independent of technology and product forms desired by the market (e.g., frozen versus canned salmon).

For shipment of processed fishery products, the most popular methods vary by process form, as would be expected. Fresh products are shipped by air freight, and also on private or commercial vessels. Air freight is used to a minor extent for the transport of frozen products also. The most popular method for frozen products is by commercial vessels, although buyer-owned or processor-owned vessels are used to some extent. Canned products are universally shipped by surface carriers, and all reported the use of commercial carriers rather than private (buyer or processor) vessels. No differences exist, at least among sample respondents, in the transportation of finfish and shellfish products. Given the past and present structure of transportation rates, process form appears to be the sole determinant of transport method. Several respondents reported an increasing shortage of commercial surface capacity in the face of expanding needs. Processors also appear to be encountering difficulty in their attempts to charter, lease or purchase freighting capacity.

Domestic Sales Practices and Trends (Re: Volume I, Appendix III; Part V, 1 through 5; Part VIII, 1a through 1c)

Processors, as judged by survey responses, sell most of their products through brokers, some through wholesalers, and very little through retailers. Normal terms are commonly used for canned and fresh/frozen products. That is, payment in full is due within 30 days with a two percent discount if payment is made by the 10th day; or 2%/10 -N 30. Consignment is used (somewhat more in fresh/frozen than canned) to a much lesser extent as is delayed billing. Prepayment appears to be used occasionally, although this was reported only by one respondent for the fresh/frozen process form.

Six of the 19 respondents reported the practice of custom processing for other firms; production advances were reported to not be a part of these transactions. Canned salmon and, to a lesser extent, frozen salmon are the target product and species for this production arrangement.

It appears that the receipt of sales advances by processors from distribution firms is uncommon, but that when it does occur, interest charges are the exception. Sales advances or other incentives would be indicative of a seller's market. Eight of 19 respondents indicated that they used incentive to attract buyers. These include, in descending order of importance, discounts from list price, advertising assistance, and coupons. Thirteen of 19 companies support cooperative product promotion through industry associations. Some companies belong to as many as five associations, although one or two association memberships are more common. For the 15 companies engaging in product promotion, the advertising-to-sales ratio ranged from less than 0.1 percent (three companies) to 2.4 percent (one company). Seven of the 15 indicated less than 1 percent, two companies reported 2 percent, while three did not respond.

International Business Arrangements (Re: Volume I, Appendix III; Part VI, 1 through 5)

Japanese ownership in the Alaska seafood processing industry is reported in another recent research report (Gorham and Orth 1978), and for this reason, questions concerning it were omitted from the survey. No companies reported ownership by companies from countries other than Japan, but one company reported that it had an ownership interest in seafood processing companies in Canada, West Germany, and Japan. Production and sales advances from foreign buyers were reported by five of 17 respondents and four of these indicated that interest is charged thereon. All respondents receiving such advances report that they are a small percentage of total liabilities (less than 10 percent). Long-term purchasing contracts were reported by three of 18 respondents. According to the survey, processors do not make advances to foreign buyers.

Entry and Exit (Re: Volume I, Appendix III; Part VII, 1a through 1c)

Eleven of 19 respondents indicated that they planned to enter other fisheries, all of which are in Alaska, except one which also has expansion plans in Washington. The target species for entry are salmon, groundfish, herring, and mollusks, and the target areas are the Bering Sea and Gulf of Alaska. Past entry has recently occurred mostly in crab, shrimp, and herring. Salmon, halibut, scallops, and groundfish have had some entrants. Herring has had three companies exit; salmon and groundfish have each had one. The most common methods of entry are the purchase of existing plant and equipment and the addition of a new product line. The purchase of subsidiaries is another method which has been utilized though to a lesser extent than the other methods. Exit occurs most frequently by the discontinuance of a product line (as opposed to the sale of a subsidiary or plant).

Plant Size Characteristics

To this point, the size distribution of plants has been examined only in terms of total production; that is, without regard to location, species, or process form. This section seeks to determine whether plant size differs by species and process form and whether, within these groups, there has been significant change over the period of this study. The reader will note that because of the high degree of plant diversity, finfish species have not been broken out for separate treatment in this section.

Tables 22 and 23 show the frequency distributions of plants by size categories for each species. Table 22 shows this information by the production of the primary species amounts only, whereas Table 23 contains a distribution based on the total production of a plant where plants are grouped by their primary species. While there appears to be no systematic size tendencies (several species appear to have bimodal distributions), the "Dif" (difference) column may be suggestive of trends in plant size; where significant increases or decreases in the number of plants within a size category suggest underlying biological, technological, or market forces that lead managers to adjust to another size of plant. Large plant sizes are less frequent in Period 2 in salmon and halibut. No clear patterns are evident in the other species except that medium-sized plants are more common. Table 24 shows average plant size by region and species. Salmon and halibut plants declined in

TABLE 22

SIZE DISTRIBUTION OF PLANTS BY SPECIES CATEGORY AND BY PERIOD
BASED ON PRIMARY SPECIES PRODUCTION

Quantity Produced[1]	Number of Plants														
	Salmon			Halibut			Herring			Crab			Shrimp		
	Period			Period			Period			Period			Period		
	1[2]	2[3]	Dif.	1	2	Dif.	1	2	Dif.	1	2	Dif.	1	2	Dif.
1 - 50,000	56	64	8	1	3	2	2	17	15	13	12	- 1	4	10	6
50,001 - 150,000	25	21	- 4	0	0	0	1	14	13	10	11	1	1	2	1
150,001 - 350,000	18	10	- 8	1	1	0	1	8	7	4	8	4	4	3	- 1
350,001 - 750,000	15	14	- 1	2	0	- 2	0	2	2	2	20	18	1	2	1
750,001 - 1,550,000	15	15	0	6	1	- 5	2	4	2	1	11	10		6	6
1,550,001 - 3,150,000	30	12	-18	4	0	- 4	0	3	3	0	3	3		5	5
3,150,001 - 6,350,000	13	2	-11	1	0	- 1	7	3	- 4	0	1	1	0	0	0
6,350,001 - 12,750,000	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
> 12,750,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Pounds of meat-weight equivalents.

[2]1956 to 1958.

[3]1973 to 1975.

TABLE 23

SIZE DISTRIBUTION OF PLANTS BY SPECIES CATEGORY AND BY PERIOD
BASED ON TOTAL PRODUCTION

Quantity Produced[1]	Number of Plants														
	Salmon			Halibut			Herring			Crab			Shrimp		
	Period			Period			Period			Period			Period		
	1[2]	2[3]	Dif.	1	2	Dif.	1	2	Dif.	1	2	Dif.	1	2	Dif.
1 - 50,000	56	64	8	0	3	3	2	16	14	9	9	0	4	8	4
50,001 - 150,000	23	21	- 2	1	0	- 1	1	10	9	8	12	4	1	4	3
150,001 - 350,000	19	9	-10	0	0	0	1	6	5	3	7	4	2	1	- 1
350,001 - 750,000	14	15	1	3	1	- 2	0	3	3	5	16	11	2	4	2
750,001 - 1,550,000	17	14	- 3	3	0	- 3	2	1	- 1	2	9	7	0	4	4
1,550,001 - 3,150,000	28	12	-16	4	1	- 3	0	6	6	1	8	7	0	4	4
3,150,001 - 6,350,000	15	3	-12	4	0	- 4	7	6	- 1	2	5	3	1	3	2
6,350,001 - 12,750,000	0	0	0	0	0	0	1	3	2	0	0	0	0	0	0
> 12,750,000	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Pounds of meat-weight equivalents.

[2]1956 to 1958.

[3]1973 to 1975.

TABLE 24

NUMBER AND AVERAGE SIZE OF PLANTS BY REGION AND SPECIES

	Salmon	Halibut	Herring	Crab	Shrimp
		Number of Plants by Primary Species			
Period 1[3]					
Southeast	61	13	9	9	8
Central	52	2	5	18	2
Western	46	0	0	3	0
AYK	13	0	0	0	0
Period 2[4]					
Southeast	24	1	10	9	3
Central	40	4	36	39	22
Western	27	0	6	18	3
AYK	47	0	0	0	0
Change					
Southeast	-37	-12	1	0	-5
Central	-12	2	31	21	20
Western	-19	0	6	15	3
AYK	34	0	0	0	0
		Average Plant Size by Primary Species[1]			
Period 1[3]					
Southeast	1,144,700	1,398,982	2,088,520	43,775	207,817
Central	954,989	934,915	4,296,677	153,679	12,580
Western	794,501			233,273	
AYK	71,493				
Period 2[4]					
Southeast	830,953	791,255	2,147,503	100,218	39,049
Central	339,643	64,381	266,835	483,477	756,419
Western	609,375		321,542	874,494	419,397
AYK	237,860				
Change					
Southeast	-313,747	-607,727	58,983	56,443	-290,003
Central	-615,346	-870,534	-4,029,842	329,798	743,839
Western	-185,126		321,542	641,221	419,397
AYK	166,367				
		Average Plant Size by Primary Species[2]			
Period 1[3]					
Southeast	2,241,936	2,462,292	2,151,066	60,107	635,036
Central	954,989	1,037,349	4,296,677	977,008	12,580
Western	794,501			233,273	
AYK	71,493				
Period 2[4]					
Southeast	951,933	1,725,110	4,605,811	445,780	41,230
Central	339,801	149,326	915,717	1,019,605	1,296,173
Western	609,375		1,021,755	921,040	419,397
AYK	37,860				
Change					
Southeast	-290,003	-737,182	2,454,745	385,673	-593,806
Central	-615,188	-888,023	-3,380,960	42,597	1,283,593
Western	-185,126		1,021,755	687,767	419,397
AYK	166,367				

Source: Compiled from data provided by Alaska Department of Fish and Game.
[1]Based on primary species amounts only (pounds of meat-weight equivalents).
[2]Based on total amounts produced (pounds of meat-weight equivalents).
[3]1956 to 1958.
[4]1973 to 1975.

size except in AYK. Shrimp plant size declined in Southeast. These data suggest that plant sizes, as measured by production data, are primarily a function of biological stock conditions, rather than technology.

The data on process forms shown in Tables 25 and 26 are consistent with this conclusion. No discernable central tendency exists in the size distribution of plant production grouped by process form. Plants whose primary process was canning fell in nearly all size categories, but large plants, those producing between 1.5 and 6.4 million pounds annually (meat weight equivalents) lost the greatest number of plants. This is probably owing to the decline in salmon stocks and the gradual shift to an increase in the proportion of salmon processed in the frozen form. Regional data, shown in Table 27 reveal the same pattern.

Structural Parameters of Individual Seafood Markets: Finfish

Although there are generalizations that one can draw from the preceding discussions about the seafood processing sector in Alaska as a whole, it is more relevant, in some cases to look at individual markets in order to determine trends that may not be easily recognizable in aggregated samples. For this reason the market concentration in individual "finfish" markets is discussed below.

Market Concentration in Detailed Halibut Markets

There are 12 potentially relevant markets for halibut if one considers the geographical divisions shown on Table 28 and the product forms. In consideration of producers as sellers, the appropriate market cells to consider would be statewide by-product form (fresh/frozen whole and fresh/ frozen fillet, cheeks, and fletches). The concentration ratios shown in these cells will be overstated, if, on a national scale, the Alaska producers must compete with halibut or similar groundfish that come from other sources.

Statewide, the four-firm concentration ratio rose from a moderate (.400) to a high concentration (.555) between Period 1 and Period 2. The total number of plants involved in the production of halibut in any form increased 63 percent over the two periods while the total production has decreased by 45 percent. With regard to the fresh/frozen whole trade statewide, the concentration ratio for Period 1 was moderate (.401) and for Period 2 was high (.550). The number of plants producing fresh/frozen whole halibut statewide rose 60 percent between Periods 1 and 2 while the production itself fell 52.5 percent. The concentration ratio for fresh/frozen fillets, cheeks, and fletches was the least between the two periods (from .930 to .984) although the absolute value of the ratio was much higher to begin with. It is notable that the production of fletches, cheeks, and fillets in Period 2 rose some 34 times the amount produced in Period 1 and the number of plants producing this change increased by 1.6 times.

If the activity of processors on the buyers' side is to reflect the true nature of the competitive climate, then the delineation of a relevent geographical market must be theoretically justified. The implication is that the smaller the geographical area, the more likely one is to find high concentration

TABLE 25

SIZE DISTRIBUTION OF PLANTS BY PROCESS FORM AND BY PERIOD
BASED ON PRODUCTION BY PRIMARY PROCESS METHOD

Quantity Produced[1]	Number of Plants											
	Fresh/Frozen			Canned			Cured			Reduction		
	Period 1[2]	Period 2[3]	Dif.	Period 1	Period 2	Dif.	Period 1	Period 2	Dif.	Period 1	Period 2	Dif.
1 - 50,000	16	40	24	19	13	- 6	35	33	- 2	1	1	0
50,001 - 150,000	14	32	18	10	0	-10	11	0	-11	0	1	1
150,001 - 350,000	13	18	5	9	0	- 9	5	2	- 3	0	0	0
350,001 - 750,000	11	34	23	7	7	0	3	0	- 3	1	1	0
750,001 - 1,550,000	5	19	14	12	7	- 5	0	0	0	1	1	0
1,550,001 - 3,150,000	3	16	13	31	21	-10	0	0	0	0	0	0
3,150,001 - 6,350,000	0	5	5	13	2	-11	0	0	0	7	0	- 7
6,350,001 - 12,750,000	0	1	1	0	0	0	0	0	0	1	0	- 1
> 12,750,000	0	0	0	0	0	0	0	0	0	0	0	0

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Pounds of meat-weight equivalents.

[2]1956 to 1958.

[3]1973 to 1975.

TABLE 26

SIZE DISTRIBUTION OF PLANTS BY PROCESS FORM AND BY PERIOD
BASED ON TOTAL PRODUCTION BY ALL PROCESS METHODS

Quantity Produced[1]	Fresh/Frozen			Canned			Cured			Reduction		
	Period 1[2]	Period 2[3]	Dif.	Period 1	Period 2	Dif.	Period 1	Period 2	Dif.	Period 1	Period 2	Dif.
1 - 50,000	16	39	23	17	13	- 4	32	29	- 3	1	0	- 1
50,001 - 150,000	14	33	19	11	0	-11	2	1	- 1	0	1	1
150,001 - 350,000	13	18	5	10	0	-10	2	2	0	0	0	0
350,001 - 750,000	11	31	20	7	6	1	5	2	- 3	1	0	- 1
750,001 - 1,550,000	5	20	15	12	7	- 5	6	1	- 5	1	0	- 1
1,550,001 - 3,150,000	2	15	13	29	19	-10	2	0	- 2	0	0	0
3,150,001 - 6,350,000	1	8	7	15	5	-10	5	0	- 5	7	2	- 5
6,350,001 - 12,750,000	0	1	1	0	0	0	0	0	0	1	1	0
> 12,750,000	0	0	0	0	0	0	0	0	0	0	0	0

(Number of Plants)

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Pounds of meat-weight equivalents.

[2]1956 to 1958.

[3]1973 to 1975.

TABLE 27

NUMBER AND AVERAGE SIZE OF PLANTS BY REGION AND PROCESS FORM

	Fresh/Frozen	Canned	Cured	Reduction
		Number of Plants by Primary Process		
Period 1[3]				
Southeast	25	35	24	5
Central	23	45	3	6
Western	14	16	19	0
AYK	0	5	8	0
Period 2[4]				
Southeast	31	10	0	2
Central	74	23	18	2
Western	33	13	4	0
AYK	27	4	13	0
Change				
Southeast	6	-25	-24	-3
Central	51	-22	15	-4
Western	19	-3	-15	0
AYK	27	-1	5	0
		Average Plant Size by Primary Process[1]		
Period 1[3]				
Southeast	413,758	1,631,568	154,274	3,716,448
Central	226,360	1,347,112	2,785	3,523,049
Western	463,895	1,902,906	11,549	
AYK		130,046	29,634	
Period 2[4]				
Southeast	948,526	833,891		647,782
Central	738,358	1,563,329	14,767	79,512
Western	604,154	1,256,197	17,024	
AYK	288,812	291,491	21,846	
Change				
Southeast	534,768	-797,677	-154,274	-3,068,666
Central	511,998	216,217	11,982	-3,443,537
Western	140,259	-646,709	5,475	
AYK	288,812	161,445	-7,788	
		Average Plant Size by Primary Process[2]		
Period 1[3]				
Southeast	511,815	1,675,110	1,588,922	3,716,448
Central	226,360	1,413,424	2,785	3,525,028
Western	463,895	1,908,307	11,549	
AYK		138,469	29,634	
Period 2[4]				
Southeast	1,054,801	1,000,867		6,536,685
Central	846,344	1,822,359	45,638	1,652,108
Western	604,732	1,325,591	173,390	
AYK	304,848	322,653	85,572	
Change				
Southeast	542,986	-674,243	-1,588,922	2,820,237
Central	619,984	408,935	42,853	-1,872,920
Western	140,837	-582,716	161,841	
AYK	304,848	184,184	55,938	

Source: Compiled from data provided by Alaska Department of Fish and Game.
[1]Based on primary process amounts only (pounds of meat-weight equivalents).
[2]Based on total amounts produced (pounds of meat-weight equivalents).
[3]1956 to 1958.
[4]1973 to 1975.

TABLE 28

STATEWIDE AND REGIONAL MARKET CONCENTRATION FOR HALIBUT PRODUCTS BY PERIOD, UNADJUSTED FOR OWNERSHIP INTERTIES

Period One (1956 to 1958)

	Number of Firms	Number of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
Statewide	31	35	29,547,600	.232	.400	.635	.065
Southeast	26	29	25,401,900	.269	.466	.715	.079
Central	6	6	4,145,700	.766	.982	1.000	.336
Western	...	...					
Fresh/Frozen: Whole							
Statewide	31	35	29,527,300	.232	.401	.635	.065
Southeast	26	29	25,383,000	.270	.466	.716	.079
Central	6	6	4,144,200	.765	.982	1.000	.336
Western	...	...					
Fresh/Frozen: Fillet Cheeks & Fletches							
Statewide	5	5	20,300	.660	.930	1.000	.283
Southeast	4	4	18,800	.712	1.000	1.000	.323
Central	*	*					
Western	...	...					

Period Two (1973 to 1975)

	Number of Firms	Number of Plants	Total Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
Statewide	48	57	16,245,100	.342	.555	.773	.101
Southeast	20	20	8,244,100	.419	.620	.811	.131
Central	28	35	7,973,500	.698	.882	.971	.274
Western	*	*					
Fresh/Frozen: Whole							
Statewide	47	56	15,525,300	.342	.550	.770	.099
Southeast	19	19	7,784,100	.414	.617	.810	.128
Central	28	35	7,713,700	.689	.878	.970	.266
Western	*	*					
Fresh/Frozen: Fillet Cheeks & Fletches							
Statewide	13	13	719,800	.593	.790	.984	.212
Southeast	11	11	460,000	.550	.807	.997	.222
Central	*	*					
Western	...	...					

Source: Compiled from data provided by the Alaska Department of Fish and Game.
[1] Individual items may not add to totals due to rounding
* Fewer than three firms

ratios, or that the analysis will break down for lack of firms or plants. This leads to a dilemma and poses a basic question to the market researchers: How does one determine a relevant market in a geographical sense? For a case where the buyer's behavior is discussed, a geographical delineation may be made on the basis of the physical or technological limitations of transport and the costs these limitations impose. Thus, for the halibut fishery the relevant market may be delineated by average vessel range, or, the ability of a fishing vessel to reach alternative points of landing that are consistent with its cost structure. Relevant markets may also be determined by the size of the buying firm, available transport and holding facilities, size (and therefore range) of vessels, bulk and perishability of the product, the presence of market information, as well as other physical constraints particular to a specific production process. The reason for discussing these conditions is to point out that the efficacy and importance of successful geographical market delineation is a basic point of controversy in market analysis. In many cases, concentration ratios can be highly sensitive to the manner in which spatial markets are defined, and spatial markets are largely determined by aggregation costs. Finfish market definition may vary if one were to justify the area designation by the considerations mentioned above. However, the costs of performing sub-market delineation for each species, and the limited availability of data in these forms make it possible only to derive concentration ratios from data collected in its existing form. For this reason, the relevant marketing areas have been defined as ADF&G statistical areas. The advantage of this, however, is that each species and product form has the same area delineations which makes the job of comparing different industries (such as salmon and halibut) easier.

When the processor is considered a buyer of raw product, the final product form becomes less important, while the geographical location of the market becomes more important. In the southeast section of Alaska, industry concentration ratios (four firms) went from moderate (.466) to high (.620) between Periods 1 and 2. Between the same two periods, the decrease in total production was 67.6 percent and the decrease in number of plants in operation was 31 percent. The four firms' concentration ratio for the central portion of Alaska reveals a decline between periods (.982 to .882) which could be attributed to a growth in the number of plants found in central Alaska of 4.8 times the number found in Period 1. The western section of Alaska, although no ratios are presented, represents an area of high concentration of firms. The effect of defining a smaller market area on the concentration ratio is shown in Tables 29 and 30 for Prince William Sound and Bristol Bay. The reader is reminded, however, that the tendency for market concentrations to increase with smaller geographic areas is a basic difficulty with market structure studies and suggests that successful spatial definition of markets is extremely important.

Market Concentration in Detailed Herring Markets

Two radical changes have occurred in the herring fishery. First, the reduction fishery, which claimed so much of production in Period 1, (Table 31) collapsed in the 1960s so that virtually no plants operated in Period 2, or those that are in operation do so to comply with environmental laws. Second, the roe and roe-on-kelp fisheries, which were nonexistent in

TABLE 29

PRINCE WILLIAM SOUND AND BRISTOL BAY MARKET CONCENTRATION FOR HALIBUT PRODUCTS FOR PERIODS ONE AND TWO, UNADJUSTED FOR OWNERSHIP INTERTIES

PERIOD 1 (1956 to 1958)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	*	*					
Bristol Bay	...	...					
Fresh/Frozen - Whole							
P. W. Sound	*	*					
Bristol Bay	...	...					

PERIOD 2 (1973 to 1975)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	7	7	160,400	.601	.867	1.000	.230
Bristol Bay	...	...					
Fresh/Frozen - Whole							
P. W. Sound	7	7	160,400	.601	.867	1.000	.230
Bristol Bay	...	...					

Source: Compiled from data provided by the Alaska Department of Fish and Game.

[1]Individual items may not add to totals due to rounding.

*Fewer than three firms.

TABLE 30

PRINCE WILLIAM SOUND AND BRISTOL BAY MARKET CONCENTRATION FOR HALIBUT PRODUCTS FOR PERIOD THREE, UNADJUSTED FOR OWNERSHIP INTERTIES

PERIOD 3 (1976)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	3	3	169,700	.788	1.000	1.000	.358
Bristol Bay	...	...					
Fresh/Frozen - Whole							
P. W. Sound	3	3	169,700	.788	1.000	1.000	.358
Bristol Bay	...	...					

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Individual items may not add to totals due to rounding.

*Fewer than three firms.

TABLE 31

STATEWIDE AND REGIONAL MARKET CONCENTRATION FOR HERRING PRODUCTS BY PERIOD, UNADJUSTED FOR OWNERSHIP INTERTIES

Period One (1956 to 1958)

	Number of Firms	Number of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
Statewide	20	22	45,103,700	.446	.663	.919	.163
Southeast	17	17	23,620,300	.445	.748	.939	.157
Central	4	5	21,483,400	.749	1.000	1.000	.367
Western	--	--					
Fresh/Frozen/ Salted: Whole, fillet							
Statewide	4	4	2,381,900	.787	1.000	1.000	.348
Southeast	4	4	2,381,900	.787	1.000	1.000	.348
Central							
Western	--	--					
Fresh/Frozen: Bait, Bait Roe							
Statewide	12	12	4,335,600	.490	.766	.963	.181
Southeast	11	11	3,561,200	.558	.815	.973	.221
Central	*	*					
Western	--	--					
Reduction - Oil & Meal							
Statewide	6	8	38,386,200	.524	.780	1.000	.220
Southeast	4	4	17,677,200	.594	1.000	1.000	.261
Central	3	4	20,709,000	.777	1.000	1.000	.394
Western	--	--					
Roe: All Processes							
Statewide							
Southeast							
Central							
Western							

Period Two (1973 to 1975)

	Number of Firms	Number of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
Statewide	55	66	36,137,200	.332	.544	.756	.094
Southeast	14	14	22,828,000	.520	.761	.924	.178
Central	36	45	11,361,600	.529	.723	.944	.175
Western	7	7	1,947,500	.904	.970	1.000	.666
Fresh/Frozen/ Salted: Whole, fillet							
Statewide	22	24	14,038,400	.395	.595	.913	.119
Southeast	13	13	6,839,100	.409	.684	.910	.144
Central	9	10	7,014,700	.791	.928	1.000[2]	.340
Western	*	*					
Fresh/Frozen: Bait, Bait Roe							
Statewide	22	24	15,710,800	.492	.780	.947	.181
Southeast	10	10	14,070,200	.542	.852	.986	.215
Central	12	12	1,563,300	.699	.866	.983	.389
Western	*	*					
Reduction - Oil & Meal							
Statewide	*	*					
Southeast	*	*					
Central	*	*					
Western	--	--					
Roe: All Processes							
Statewide	22	30	5,090,700	.458	.670	.854	.150
Southeast	9	8	1,827,300	.742	.961	1.000	.314
Central	13	20	1,684,100	.492	.670	.901	.156
Western	*	*					

TABLE 31 (Continued)

Period One (1956 to 1958)

	Number of Firms	Number of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Roe on Kelp - All Processes							
Statewide							
Southeast							
Central							
Western							

Period Two (1973 to 1975)

	Number of Firms	Number of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Roe on Kelp - All Processes							
Statewide	22	23	1,058,000	.277	.492	.740	.086
Southeast	...	...					
Central	18	19	931,700	.315	.559	.835	.105
Western	4	4	126,300	.679	1.000	1.000	.310

[1]Individual items may not add to totals due to rounding.
[2]At three significant digits, this ratio rounded to 1.
*Fewer than three firms.

Source: Compiled from data supplied by the Alaska Department of Fish and Game.

Period 1, have become the major pillar of the industry. The other major herring fishery is the bait-packing industry. In all, from both periods, there are 24 different geographical and product form markets.

Another interesting aspect of the herring industry is that the periods describe two different industry motivations that make intertemporal comparisons of concentration ratios on the seller's side difficult. For example, Period 1 covers the last years of the herring fishery that were based primarily on reduction and curing of herring. Since Period 1 was near the time when the herring fishery and industry suffered some of its heaviest setbacks, the high concentration ratios for the whole state in this period for fresh/frozen/salted whole and fillets as well as reduction meal and oil (1.00 and .780 four-firm concentration ratio) reflect a low participation statewide due to the exit of many firms. The lower concentration ratios in the fresh/frozen/salted whole category (Table 31) in Period 2 reflect the entry of 20 new plants statewide and the shift in emphasis from cured frozen fish products for traditional markets in competition with the East Coast and Europe to the freezing of whole herring for the Japanese roe markets.

For the fresh/frozen bait and bait roe markets statewide, the four-firm concentration ratio rose very little (.766 to .780) from Period 1 to Period 2, although the absolute values of these ratios are very high. Statewide, the four-firm concentration ratio for roe, all processed in Period 2, was high (.670). For roe-on-kelp processes, the statewide four-firm concentration ratio was moderate in Period 2. On the buyers' side, Table 31 suggests that over the two periods, a change in the competitive climate has been most evident in the central region of the state, where the four-firm concentration ratio has fallen from 1.00 in Period 1 to .723 in Period 2. This seems largely due to an increase in the number of plants from five to 45. The four-firm concentration ratio has increased in the southeast portion of the state from .748 in Period 1 to .761 in Period 2. While production in Southeast has only declined 3.4 percent between periods, the reduction in the number of operating plants has been by 17.7 percent. The western portion of Alaska has a very high degree of buyer concentration in Period 2, but no data was recorded for this area in Period 1.

Tables 32 and 33 show concentration ratios and Herfindal Indexes for three periods (1976 is the third period) for Prince William Sound and Bristol Bay. An interesting trend can be followed over the three periods for Prince William Sound. The statewide four-firm concentration ratios for all products in Period 1 was 1.00 (three firms). In Period 2, this ratio was .793 (22 firms) and in Period 3 was .681 (10 firms). This suggests that in Prince William Sound, the buying sector of the herring fishery has become less concentrated through time at the four-firm level.

Market Concentration in Detailed Salmon Markets

There are 25 potentially relevant markets for salmon, including the geographical areas and the product types found in Table 34. The salmon processing industry is also one of the least concentrated markets, both from the aspect of the selling of the final product, as well as the buying of raw product.

TABLE 32

PRINCE WILLIAM SOUND AND BRISTOL BAY MARKET CONCENTRATION FOR HERRING PRODUCTS FOR PERIOD ONE AND TWO, UNADJUSTED FOR OWNERSHIP INTERTIES

PERIOD 1 (1956 to 1958)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	3	3	9,432,200	.918	1.000	1.000	.439
Bristol Bay	...	...					
Fresh/Frozen/ Salted-Whole Fillet							
P. W. Sound	...	...					
Bristol Bay	...	...					
Fresh/Frozen - Bait, Bait Roe							
P. W. Sound	*	*					
Bristol Bay	...	...					
Reduction Oil Meal							
P. W. Sound	*	*					
Bristol Bay	...	...					
Roe - All Processes							
P. W. Sound	...	...					
Bristol Bay	...	...					
Roe on Kelp - All Processes							
P. W. Sound	...	...					
Bristol Bay	...	...					

TABLE 32 (Continued)

PERIOD 2 (1973 to 1975)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	22	22	3,653,800	.691	.793	.905	.376
Bristol Bay	5	5	354,300	.796	.970	1.000	.363
Fresh/Frozen/ Salted-Whole Fillet							
P. W. Sound	3	3	2,631,400	.951	1.000	1.000	.695
Bristol Bay	*	*					
Fresh/Frozen - Bait, Bait Roe							
P. W. Sound	3	3	118,000	.887	1.000	1.000	.533
Bristol Bay	...	...					
Reduction Oil Meal							
P. W. Sound	...	...					
Bristol Bay	...	...					
Roe - All Processes							
P. W. Sound	3	3	215,800	.772	1.000	1.000	.365
Bristol Bay	*	*					
Roe on Kelp - All Processes							
P. W. Sound	15	15	688,700	.426	.660	.877	.138
Bristol Bay	4	4	126,300	.679	1.000	1.000	.310

Source: Compiled from data provided by the Alaska Department of Fish and Game.

[1]Individual items may not add to totals due to rounding.
*Fewer than three firms.

TABLE 33
PRINCE WILLIAM SOUND AND BRISTOL BAY MARKET CONCENTRATION FOR HERRING PRODUCTS FOR PERIOD THREE, UNADJUSTED FOR OWNERSHIP INTERTIES

Period 3 (1976)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	10	10	427,500	.400	.681	.942	.142
Bristol Bay	*	*					
Fresh/Frozen/ Salted-Whole Fillet							
P. W. Sound	*	*					
Bristol Bay	...	...					
Fresh/Frozen - Bait, Bait Roe							
P. W. Sound	...	...					
Bristol Bay	...	...					
Reduction Oil Meal							
P. W. Sound	...	...					
Bristol Bay	...	...					
Roe - All Processes							
P. W. Sound	5	5	117,500	.607	.984	1.000	.265
Bristol Bay	...	...					
Roe on Kelp - All Processes							
P. W. Sound	6	6	231,000	.559	.905	1.000	.237
Bristol Bay	*	*					

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]Individual items may not add to totals due to rounding.
*Fewer than three firms.

TABLE 34

STATEWIDE AND REGIONAL MARKET CONCENTRATION FOR SALMON PRODUCTS BY PERIOD UNADJUSTED FOR OWNERSHIP INTERTIES

	Number of Firms	Number of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
Statewide	142	186	181,650,400	.190	.319	.458	.039
Southeast	61	78	82,195,000	.190	.292	.471	.043
Central	55	63	61,978,900	.272	.416	.624	.071
Western	43	46	36,547,100	.446	.650	.852	.140
AYK	11	13	929,400	.718	.870	.986	.274
Canned							
Statewide	74	98	151,240,400	.225	.372	.540	.052
Southeast	34	36	60,390,500	.238	.377	.586	.062
Central	38	45	59,873,200	.276	.425	.635	.073
Western	11	14	30,326,500	.538	.784	.995	.198
AYK	5	5	650,200	.811	.988	1.000	.361
Fresh/Frozen - Whole Fillet							
Statewide	50	58	24,709,800	.238	.359	.524	.053
Southeast	32	38	16,930,500	.348	.469	.669	.087
Central	17	18	1,783,600	.326	.565	.886	.112
Western	13	13	5,993,100	.367	.588	.922	.124
AYK	*	*					
Specialty							
Statewide	60	65	4,893,900	.289	.431	.634	.070
Southeast	24	28	4,153,300	.340	.508	.748	.093
Central	7	7	236,700	.918	.990	1.000	.544
Western	20	20	227,400	.530	.666	.809	.205
AYK	9	10	276,600	.619	.820	.995	.265
Roe							
Statewide	5	13	806,200	.843	1.000[2]	1.000	.496
Southeast	4	10	720,700	.875	1.000	1.000	.511
Central	3	3	85,500	.997	1.000	1.000	.506
Western	...	...					
AYK	...	...					

	Number of Firms	Number of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
Statewide	146	186	123,141,900	.198	.325	.478	.041
Southeast	34	36	40,800,400	.265	.392	.606	.067
Central	57	73	51,881,300	.283	.489	.763	.089
Western	26	30	19,287,800	.267	.489	.836	.096
AYK	45	47	11,172,300	.256	.446	.725	.078
Canned							
Statewide	46	63	72,489,100	.270	.464	.643	.073
Southeast	14	15	17,534,600	.397	.628	.900	.134
Central	21	28	37,005,100	.326	.586	.855	.114
Western	13	14	16,349,600	.287	.544	.905	.112
AYK	6	6	1,599,700	.728	1.000[2]	1.000	.339
Fresh/Frozen - Whole Fillet							
Statewide	105	124	43,023,500	.114	.213	.364	.028
Southeast	26	26	20,257,500	.234	.419	.646	.068
Central	39	46	12,015,900	.273	.499	.705	.080
Western	18	20	2,094,900	.488	.636	.864	.153
AYK	30	32	8,655,300	.323	.519	.805	.098
Specialty							
Statewide	40	41	810,800	.519	.641	.819	.154
Southeast	*	*					
Central	20	21	363,300	.707	.812	.901	.412
Western	4	4	68,100	.939	1.000	1.000	.517
AYK	15	15	378,900	.637	.887	.987	.309
Roe							
Statewide	72	99	6,818,500	.239	.374	.558	.057
Southeast	25	27	3,007,900	.469	.643	.784	.172
Central	22	34	2,497,000	.292	.488	.780	.093
Western	13	14	775,200	.354	.637	.914	.127
AYK	23	24	538,300	.367	.508	.723	.121

[1]Individual items may not add to totals due to rounding.

From the selling side, the product type with the largest statewide four-firm concentration ratio for the first period is the roe products market (1.00). The Period 2 concentration ratio fell to .374 (moderate concentration), statewide. This is due in part to the great boom in exports of salmon roe to Japan, which has become a major commodity and has drawn 67 more firms and 86 more plants into the business between the two periods. The product type with the lowest four-firm concentration statewide in Period 1 is fresh/frozen/whole and fillet salmon with .359 (moderate concentration). The number of participating firms was 50 and the number of plants was 58. This statewide concentration figure fell to .213 (low concentration) in Period 2 with 105 firms and 124 plants participating in this market.

Both canned and specialty salmon items in the statewide four-firm concentration increased from Period 1 to Period 2. The canned products increased from .372 to .464 (moderate concentration) and the specialty items increased from .431 (moderate) to .641 (high). In both the canned and specialty markets, there were decreases in the number of firms in the business. However, Period 2 samples from 1973 through 1975 include some of the worst salmon runs in the history of the fishery, which may partially explain the higher concentration ratios. On the buying side, the central portion of Alaska made the largest increase in concentration. The four-firm concentration ratio rose from .416 in Period 1 to .489 in Period 2. The southeast portion of Alaska also experienced an increase in buyer concentration from .292 (low) to .392 (moderate) through what appears to be a large reduction in firms and plants. Further west, in the western section of the state, there was a fairly large decrease in buyer concentration (from a high value of .650 to a moderately low value of .489); as well as in the Arctic-Yukon-Kuskokwim (AYK) areas where the four-firm ratio fell from a high value of .870 to .446 from Period 1 to Period 2. The large reduction in concentration in the AYK area may be attributable to the increase in the number of participating firms as well as increases in production.

Tables 35 and 36 show market concentration characteristics for firms participating in the salmon fishery in Prince William Sound and Bristol Bay. Over three periods (Period 1, Period 2, and 1976), Prince William Sound's (PWS) production has remained in the same basic range, while the number of firms operating has declined. For 15 firms in Period 1, the concentration ratio was .841. For 11 firms in Period 2, the ratio increased to .895, and for Period 3 (1976) the concentration ratio for nine firms was .952. Bristol Bay also experienced a decline in the number of participating firms, but along with the decline in firms came a large decrease in production in Period 2. The ratio subsequently dropped from .656 (high) to .492 (moderate). In Period 3, Bristol Bay's firm participation fell even further but production rose from 19.191 million pounds to 33.484 million pounds. The ensuing rise in the concentration ratio suggests that for the smaller market areas, changes in the number of firms as well as yearly success in the salmon fishing season, produced major changes in the concentration ratios.

TABLE 35
PRINCE WILLIAM SOUND AND BRISTOL BAY MARKET CONCENTRATION FOR HERRING PRODUCTS FOR PERIODS ONE AND TWO, UNADJUSTED FOR OWNERSHIP INTERTIES

PERIOD 1 (1956 to 1958)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	15	15	13,646,700	.569	.841	.972	.212
Bristol Bay	36	39	36,252,100	.450	.656	.859	.142
Canned							
P. W. Sound	12	12	13,355,400	.581	.860	.988	.221
Bristol Bay	9	12	30,186,900	.540	.787	1.000	.200
Fresh/Frozen - Whole Fillet							
P. W. Sound	*	*					
Bristol Bay	10	10	5,870,000	.375	.600	.941	.129
Specialty							
P. W. Sound	*	*					
Bristol Bay	18	18	195,000	.590	.692	.840	.260
Roe							
P. W. Sound	*	*					
Bristol Bay	...	...					

PERIOD 2 (1973 to 1975)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Total All Products							
P. W. Sound	11	11	12,127,500	.535	.895	.999	.216
Bristol Bay	25	27	19,191,300	.269	.492	.840	.097
Canned							
P. W. Sound	8	8	9,509,200	.546	.912	1.000	.226
Bristol Bay	13	14	16,349,600	.287	.544	.905	.112

TABLE 35 (Continued)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herfindal Index
Fresh/Frozen - Whole Fillet							
P. W. Sound	7	7	2,148,800	.574	.869	1.000	.219
Bristol Bay	17	17	2,001,200	.511	.666	.896	.164
Specialty							
P. W. Sound	*	*					
Bristol Bay	3	3	65,300	.979	1.000	1.000	.560
Roe							
P. W. Sound	4	4	459,600	.677	1.000	1.000	.284
Bristol Bay	13	14	775,200	.354	.637	.914	.127

Source: Compiled from data provided by the Alaska Department of Fish and Game.

[1]Individual items may not add to totals due to rounding.
*Fewer than three firms.

TABLE 35 (Continued)

	# of Firms	# of Plants	Total[1] Production	Conc. ratio of 2 largest firms	Conc. ratio of 4 largest firms	Conc. ratio of 8 largest firms	Herf In
Fresh/Frozen - Whole Fillet							
P. W. Sound	7	7	2,148,800	.574	.869	1.000	.2
Bristol Bay	17	17	2,001,200	.511	.666	.896	.1
Specialty							
P. W. Sound	*	*					
Bristol Bay	3	3	65,300	.979	1.000	1.000	.5
Roe							
P. W. Sound	4	4	459,600	.677	1.000	1.000	.2
Bristol Bay	13	14	775,200	.354	.637	.914	.1

Source: Compiled from data provided by the Alaska Department of Fish and Game.

[1]Individual items may not add to totals due to rounding.
*Fewer than three firms.

TABLE 36

PRINCE WILLIAM SOUND AND BRISTOL BAY MARKET CONCENTRATION FOR SALMON PRODUCTS FOR PERIOD THREE, UNADJUSTED FOR OWNERSHIP INTERTIES

Period Three (1976)

	# of Firms	# of Plants	Total Production	Conc. Ratio of 2 Largest Firms	Conc. Ratio of 4 Largest Firms	Conc. Ratio of 8 Largest Firms	Herfindahl Index
Total All Products							
P. W. Sound	9	9	12,821,200	.549	.952	1.000[1]	.235
Bristol Bay	17	18	33,484,300	.440	.672	.918	.144
Canned							
P. W. Sound	7	7	10,055,100	.630	.999	1.000	.271
Bristol Bay	13	13	30,662,700	.460	.692	.939	.153
Fresh/Frozen - Whole Fillet							
P. W. Sound	5	5	2,310,400	.532	.906	1.000	.222
Bristol Bay	7	8	1,766,400	.635	.881	1.000	.242
Specialty							
P. W. Sound							
Bristol Bay	*	*					
Roe							
P. W. Sound	5	5	466,700	.789	.999	1.000	.371
Bristol Bay	8	8	1,054,100	.605	.839	1.000	.252

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]At three significant digits, this ratio rounded to 1.
*Fewer than three firms

Summary

Table 37 shows summary data for all species included in this study and by process form for salmon and crab. These industries, when viewed from their selling or final market side, are for the most part only moderately concentrated. Given that Alaska producers compete with those from other states except for king crab and tanner crab, this assessment of concentration overstates actual concentration to some degree. Within Alaska, statewide concentration has declined since statehood except for herring and canned salmon.

When these same industries are viewed from the buying or raw-product-acquisition side, however, market concentration ranges from moderate to very high. In halibut, herring, and crab meats, buyer concentration is especially high. Geographically, buyer concentration has increased or remained unchanged in all species in Southeast Alaska. In Central Alaska, buyer concentration has declined or remained unchanged in every market except canned salmon. In both Southeast and Central the level of concentration ranges from moderate to very high. In Western Alaska, buyer concentration fell or remained the same in all markets, although it was at a high to very high level in the 1973 to 1975 period. AYK, which has only a salmon industry, has experienced high but declining buyer concentration.

Overall, concentration is shown to be inversely related to the size of the market, which for these high-valued species is dependent upon stock status. Growth fisheries tend to have high concentration in their incipiency but the level tends to decline as expansion occurs. On the other hand, contracting fisheries experience increasing concentration as consolidation occurs and as plants are abandoned or shut down. From the harvester's point of view, buyer concentration is a local, rather than regional, phenomenon and is usually very high. On the selling side, concentration appears not to be a significant factor except perhaps for canned salmon.

No adjustment for ownership interties has been made in these data; therefore, conclusions about actual concentration must be tempered accordingly. The effect of not adjusting concentration measures for ownership ties is, of course, understatement of both buyer and seller concentration. Likewise, in discussing buyer (processor) concentration, no explicit consideration has been given to the fact that fishermen's bargaining cooperatives exert countervailing power against processors.

The descriptive information on seafood processing industry structure contained in this chapter will have many useful applications. Misapplication could result from the out of context use of structural information of the biological, technological, and regulatory environment surrounding each industry. For this reason, this research report includes detailed treatment of basic industry conditions for each seafood industry studied. This information for finfish is contained in Chapters III to XIV of this volume.

TABLE 37

SUMMARY OF LEVEL AND TRENDS IN MARKET CONCENTRATION

	Final Product Market		Resource Markets							
			Southeast		Central		Western		AYK	
Species	Current[2]	Change[3]	Current[2]	Change[3]	Current[2]	Change[3]	Current[2]	Change[3]	Current[2]	Change[3]
Finfish										
Halibut	H	↑	H	↑	VH	n.c.				
Herring	H	n.c.	VH	n.c.	H	↓	VH	n.a.		
Salmon	M	n.c.	M	n.c.	M	n.c.	M	↓	M	↓
Canned	M	n.c.	H	↑	H	↑	H	↓	VH	n.c.
Frozen	L	↓	M	n.c.	H	n.c.	H	n.c.	H	↓
Shellfish										
Shrimp	M	↓	VH	n.c.	M	↓	VH	n.a.		
Crab	M	↓	H	n.c.	M	↓	H	↓		
Frozen Shell	M	↓	VH	n.c.	M	↓	VH	n.c.		
Frozen Meat	H	↓	H	n.c.	VH	n.c.	H	↓		
Canned Meat	VH	↓	VH	↑	VH	n.c.				

Source: Compiled from data provided by Alaska Department of Fish and Game.

[1]As measured by the following ranges of the four-firm concentration ratio: <.30 = Low (L); .30-.50 = Moderate (M); .50-.75 = High (H); .75-1.00 = Very High (VH); n.c. - No Change; n.a. = No basis for comparison to earlier period due to lack of production.

[2]Current refers to Period 2 (1973 to 1975).

[3]Change is from Period 1 (1956 to 1958) to Period 2 (1973 to 1975).

Basic industry conditions--especially biological and regulatory--appear to be the primary sources of concentration in the Alaska seafood processing industries. With the exception of significant barriers to entry caused by over-exploited stocks and consequent over-capitalization of harvesting and processing in salmon and halibut, barriers to entry and exit appear to be low. One would expect, therefore, that concentrations of production would tend to be unstable in expanding fisheries. This, in fact, has been the pattern in Alaska's growth industries.

On the other hand, local buyer concentration will undoubtedly remain high as it is a function of economies of scale, the geographic distribution of fish stocks, and the vast coastal distances. Changes in harvesting and/or tendering technology are the only apparent sources of future instability in local buyer concentration. Improved preservation methods onboard vessels (e.g., refrigerated seawater and onboard freezing) would increase the range of options of landing ports, causing the relevant geographic market to expand and buyer concentration to decline. The successful expansion of harvesters into processors via cooperatives would change the ownership and earning patterns of processing facilities. This would have little actual impact upon local concentration levels, however, unless the underlying biological and marketing forces were expansionary. The main effect of a harvester-owned processing cooperative, if successful, would be to mitigate the tendency of high buyer concentration to depress exvessel prices.

CHAPTER III

HISTORY OF THE HALIBUT FISHERY

Introduction

The history of the halibut fishery has been chronicled in so many different pieces of research for so long it is impossible to be comprehensive in this report. However, an attempt has been made to give the reader an idea of what the industry considered to be the most interesting and urgent issues of the day in addition to the more prosaic reporting of government bodies. Each year is synoptic and covers issues that were reported in Pacific Fisherman, International Pacific Halibut Commission Annual Reports, and the Department of Commerce Series, Food Fish Market Review and Outlook.

A Chronology of the Halibut Fishery

1887 The North Pacific Railroad was completed to Tacoma.

1888 New England halibut schooners arrived. A first attempt at rail shipment of halibut to East Coast ensued.

1892 The first cold storage company in Puget Sound began operation.

1897 Special permission was extended to the New England Fish Company to allow American vessels to land fish in Vancouver, and later, to Prince Rupert.

1903 Puget Sound had five cold storage plants.

1909 First cold storage in Ketchikan.

1913 First cold storage in Sitka. The completion of Canada's Grand Trunk Railroad,and cold storage was also completed at Prince Rupert. Anchor cables came into wide use. Development of the longline was completed.

1915 First American catches of halibut were landed in Prince Rupert. Power hoists and gurdies came into wide use.

1917 War conditions not only spurred landings of all fish including halibut, but also accelerated the northward move of halibut fishing and processing to Alaska.

1918 Although stocks were poor, war dictated increased production. A general relaxing of port restrictions between Canada and the U.S. occurred at the International Fisheries Commission's (IFC) urging.

1919 Strike in British Columbia diverted halibut catch to Puget Sound. Marketing cooperatives entered the halibut industry on large scale. Halibut convention went before the Senate for ratification with the proposed closed season from November 16 to February 15.

1920 Battery power and diesel engines came into general use.

1921 Shipping strike in the United States forced Alaska deliveries through Prince Rupert. The first refrigerated railroad cars were delivered for the Grand Trunk Railroad.

1922 Duty on Canadian-caught halibut was raised to two cents per pound. There was no duty on American caught halibut if it was shipped in bond to the U.S. Diesel engines gained great acceptance and freezing plants improved through advances in refrigeration technology.

1924 After much political controversy on both U.S. and Canadian sides, the International Pacific Fishery Commission was formed and the first officially closed season (November 16 to February 15) began amidst strong opposition by American fishermen. There were increased deliveries to Prince Rupert and cold storage owners were hoarding in anticipation of a lean season to follow.

1925 The first Japanese exports of halibut were shipped to the United States. The 1925 supply of herring bait fell short. There was increased resistance by vessel owners to grading techniques by the buyers.

1928 The Fishing Vessel Owners Association grew to 189 members, located mostly at Ketchican and Petersburg. Organized boat-share negotiations between vessel owners and fishermen became common.

1930 Fishermen opposed the treaty that would give the Commission strong powers of resource and exploitation control.

1931 Disputes between vessel owners and fishermen led to a tie-up. Also, buyers began grading mediums, a prime fish size 10-60 pounds instead of the customary 10-80 pounds. The new halibut treaty gave the IFC control over closures and quotas. IFC formed an advisory board of boat owners and fishermen.

1933 Seattle average price jumped 43 percent in response to catch controls and quantity of fish landed. Seattle became the largest halibut port in the world for a second year. Fishing Vessel Owners Association suggested a voluntary tie-up to extend the fishing season later in the year. This was widely accepted with the exception of some Canadian and Alaska fishermen. Catch per man per trip limits were imposed.

1934 Price advantage of mediums was diminished. Voluntary tie-ups and catch per man per trip quotas failed in Area 2 (see Appendix I).

1935 The average price of all grades climbed to unprecedented highs due to a shortfall in catch. Halibut livers experienced an explosive demand, and consequently, an explosive price. A delay in fishing partially ensured a reduction of frozen stocks and gave fishermen more time to gain guarantees of a minimum price from buyers prior to the season. Dory fishing was outlawed in Area 2 and tariffs on catch from Canadian vessels decreased to one cent per pound starting January 1, 1936.

1936 Landings in Alaska rose sharply by 30.6 percent. The catch for 1936 was steadily increased over the whole coast. Western halibut (Alaskan halibut), traditionally commanding a slightly lower price, was boosted by the continuation of the Area 3 season three months after the close of Area 2. Halibut livers commanded 45 cents per pound on 1936 contracts.

1937 While the Canadian fleet was increasing, the U.S. fleet was on the decline. However, all landings in Alaska, with the exception of Petersburg, had increased dramatically. The

Halibut Production Control Board, a joint effort by members of industry, was still active. The Enabling Laws, enacted in 1937, permitted the Halibut Commission to "Permit limit regulations and prohibit...incidental halibut fishing at any time or in any area." Cod boats were given the famous 1:7 ratio (one pound of halibut to seven pounds of cod). Halibut livers hit 50 cents per pound.

1938 Chicken halibut faced weaker markets while larger halibut faced strong markets because of a strong seasonal carry-over and phenomenal catch. Large landings, however, caused retail halibut prices to plummet and prompted the voluntary control program. The fleet was divided by areas and vessel owners' names (alphabetically). Trip limits of 2,500 lbs/man in Seattle and 2,800 lbs elsewhere were in effect. A decreasing term voluntary tie-up was instituted.

1939 Both Canada and the U.S. had begun a preparation for war. Alternative fisheries were being eyed and, therefore, different boat types were being tried. Differential closure of Areas 2 and 3 created a rise in price. This was the first variation from the traditionally devalued western halibut and placed Alaskan fishermen in a good bargaining position.

1940 Area 2 landings were increasing due to over catching. Requests for increases in limits by the curtailment board, the voluntary control program, were turned down by the commission. Although the control of the halibut fleet was still voluntary, the credibility was in question because of breaches in agreement and new boats entering the fishery. A lower weight limit for chicken halibut was imposed at 5 pounds 13 ounces, head on, entrails removed.

1941 Seattle could no longer be considered the principal halibut port. The halibut liver market began to meet sharp competition from shark and codfish livers. England left the halibut market as a buyer, thereby increasing Canadian sale of halibut in the U.S. Ketchikan led Alaskan ports in halibut landings.

1942 The Canadian fleet decreased because of the war, but Prince Rupert became the leading halibut port in the Pacific Northwest largely as a result of increased American sales. Alaskan landings also increased in 1942. Shortened seasons were seen as the reason that more halibut sales were made up north. Seattle markets were hurt by the war and especially by the Office of Price Administration. The voluntary curtailment program was abandoned.

1944 The Pacific Fisherman's Annual reported that the Seattle Otter Trawlers Association would no longer advocate or condone the taking of halibut by trawl gear. The official opening was late by five weeks because of conflict between the fleet and the Office of Price Administration (OPA). OPA policy in the end boosted Alaska landings over 14 million pounds to 21 million pounds and subsequently shifted trade to the mid-west (served by Seattle and Prince Rupert) and the far-west (served by Seattle) by reversing the normal flow of trade by using ceiling prices. This led to black market transactions in Seattle at prices over the ceiling. Dory gear was prohibited in Areas 3 and 4.

1945 Halibut production in this year reached its highest level since 1929. The one in seven rule remained for other white fish fisheries. The seasons were the shortest in history. Halibut was again marketed under federal allocations from the Office of Commercial Fisheries (OCF). This accelerated Alaska's dominance as a major halibut producer.

1946 The halibut catch passed 60 million pounds--the highest catch since 1917. The price of halibut shot up to 30 cents per pound after Area 2 closed. Port allocations were not revoked this year.

1947 Catch took a dive when fishermen and vessel owners got into a dispute about the lay (cut) for the vessel owner and the boat. Settlement came only after Area 2 was closed. This is the year that British Columbia cooperatives became noticeably powerful.

1948 Landings in west Alaska had increased due to new storage facilities at Sand Point. However, Ketchikan was still the leader in the landings of halibut in Alaska. Seattle received much attention from Canadian sellers. The change in buying habits as a result of price differentials ceased to exist between medium and large halibut, although chicken halibut (less than 10 pounds) were in low demand. In this year, the first proposal for split seasons was made.

1949 The split season was advocated because different stocks were thought to occur on different grounds at different times. Fishermen, however, were in favor, at this time, of extending seasons because of the apparent plentiful supply. OPA still controlled ceiling prices. Alaska imposed a tax program for fishing which charged five dollars per year for a resident and fifty dollars per year for non-residents. This was overthrown in the courts if the fish were taken outside the three-mile limit. A raw fish tax of one percent of the price paid for any fish landed in the territory for shipment fresh, frozen, or cured was imposed. Steel gear and small craft refrigeration, in addition to ice, became popular.

1950 A convention was signed between Canada and the U.S. that would provide for extension of port privileges for halibut and sablefish fishing vessels and permit landings without payment of duty other than that required by customs.

1952 For the first time, there was loud praise for the IPHC, along with unprecedented catches. Split seasons seemed to alter landing patterns.

1953 Again bumper catches occurred. Alaska trade suffered from a non-quota split season with light Area 3 fishing and good fishing from Area 2. The new U.S.-Canadian treaty was ratified by the senate in July.

1954 Again, unprecedented halibut production. The split season concept, although popular with beneficiaries, was eyed with some fear by Alaskan processors who benefited from the short, non-split season.

1955 Prices collapsed presumably because of the 1954 season. However, the 1955 fishing season was also poor because of weather and poor stock abundance.

1956 The use of chilled sea water for preservation of fish was developed. Renewed research efforts in the Bering Sea occurred.

1958 Canada's share of the catch grew. IPHC established an early season in the Bering Sea. The Aleutian cold storage plant was constructed. Under terms of INPFC, Japan was to abstain from taking halibut in designated areas of the North Pacific.

1961 Japanese and Russian fishing effort increased phenominally in the Bering Sea. The Japanese catch of halibut was roughly one-third of the total catch of Canadian and the U.S., which suggested wholesale violation of abstention. The Halibut Association of North America was incorporated, with an unprecedented industry participation of 95 percent, for the purpose of advertising halibut on a national scale.

1962 The Japanese fished the eastern Bering Sea with impunity although in probable violation of abstention. Prices were high in 1962 because of an early season without quotas north of the Alaska Peninsula and Aleutian Islands and because of the Halibut Association of North America's promotion.

1965 Versatility in vessels became a popular goal for designers and fishermen. Air express shipments were eyed as possible alternatives to conventional distribution. Alaska took the lion's share of the nations catch. There was a northward trend of exvessel halibut sales, as a result of the shortening of the seasons. Seattle processors then raised prices in response to the decreased volume flowing through its ports.

1966 Quantity of halibut for U.S. consumption was below that of 1965 because of reduced imports. The quota set for controlled areas by IPHC was 59.5 million pounds (dressed). Catch was 624 million pounds. Alaska led in halibut landings. Improvement in handling, storage, and transport facilities in Alaska encouraged more vessels to sell their catch in Alaska rather than make the four or five-day run to Seattle. With wholesale prices up, sales declined. Seattle was still the major halibut distribution center.

1967 For the first time since 1947, landings in 1967 did not reach quotas set by IPHC. Apparently fishing effort was reduced partly because of poor seasonal prices, a strike in Southeast Alaska by cold storage employees, and a strike in British Columbia. Imports of halibut decreased. Consumer resistance to high prices in 1966 resulted in lower prices in 1967.

1968 Supplies of halibut were seven percent lower than in 1967. Combined landings of Alaska and Canada were the lowest since 1936 and failed to meet IPHC quotas, even though those quotas had been lowered. Imports, on the other hand, were the highest since 1963. Halibut sales were slightly higher due to slight price depression in 1967.

1969 Japanese, Soviet, and Korean fishing operations exerted heavy pressure against outside regulation areas in the North Pacific and Bering Sea. U.S. and Canadian landings were good and exvessel prices reached a record high.

1970 IPHC reduced quotas from 55.5 to 53 million pounds.

1971 For the fourth year imports exceeded domestic landings. The combined United States-Canadian catch of Pacific Coast halibut was far below the quotas set by IPHC and the lowest amount landed since 1933.

1972 All halibut product forms became free entry items.

1973 There was a sharp decline in both domestic landings and imports. Declines in abundance were attributed to the large unregulated foreign fishery off Alaska and British Columbia. All of these occurrences led to subsequent quota decreases by IPHC.

1974 Continuing resource problems caused the catch in 1974 to be the lowest since the inception of the fishery in 1895. U.S. imports from all countries plummeted as prices skyrocketed. This is testimony to the fact that when the North Pacific fails to produce halibut there are serious repercussions in halibut markets worldwide.

1975 The 1975 catch of Canada and the U.S. nearly reached the 25-million-pound quota established by IPHC. Canada increased shipments to the U.S. Japan, largely at the urging of IPHC, appeared to have relented in its exploitation near the management areas.

1976 The low level of the resource and limited catches was reflected again in curtailed world trade. In addition, market stagnation appeared to occur due to the great increase in prices at the retail level.

1977 The voluntary tie-up program was abandoned by industry for lack of support.

A general fishing boundary dispute occurred in the spring of 1978 between Canada and the United States. All U.S. fishermen, including those in the halibut fishery were ordered out of Canadian waters. As a result, the future of the International Pacific Halibut Commission (IPHC) was placed in jeopardy and the 55-year-old cooperative effort in conservation between Canada and the United States stagnated. The date for expiration of funds was April 1, 1979. At least one bill was submitted to the committee on Merchant Marine and Fisheries by Representatives Pritchard and Young in October of 1978, calling for a transfer of halibut research and management functions to NMFS at the Northwest and Alaska Fisheries Center.

However, tentative agreements have been negotiated recently that would phase out Canadian fishing involvement in Alaska over a two-year period. Under the same agreement, the West Coast management of the halibut resource would be kept under the IPHC and allow Washington bottomfish (white fish) fishermen to operate in British Columbia waters for the next two years (Painter, March 1979).

The protocol does allow both governments to amend any of the provisions regarding Canadian access. Paragraph 5 of the agreement also provides for consultations on future fisheries cooperation prior to March 31, 1981 (Mackenzie 1979).

With the institution of the Fishery Conservation and Management Act (FCMA), the treaty providing for the existence of the IPHC (as well as other international fisheries agreements) was in danger of expiring. However, there are benefits for both countries in allowing IPHC to function. These benefits concern bilateral control and monitoring of the whole resource and reciprocal fishing agreements which allow U.S. and Canadian harvesting off both Alaska and British Columbia.

Additional Observations

Several conclusions may be drawn from the short historical account presented to the reader:

1. Markets for halibut were, for all practical purposes, ready-made because people have eaten and wasted halibut since the middle ages. With this widespread consumer acceptance came heavy exploitation of Atlantic stocks and depletion of the resource in the late 1800s.

2. For reasons outlined in 1., exploitation of halibut on the West Coast began. The formation of railroads is the single most important event that spurred not only exploitation but expansion of the halibut fishery into the northwest region of the Pacific. Advances in refrigeration and diesel engine technology further accelerated this trend. The northward movement of the fleet also radically changed the marketing and distribution of halibut.

3. Ever since the early 1900s, there has been considerable interaction between Canada and the U.S. with regard to many fisheries. Various extension of port privileges and tariff reductions signified that the senate, although grudgingly, perceived some relaxation of barriers between Canada and the U.S. to be desirable. However, on the whole, Canada was more anxious to have closer ties and as a result unilaterally extended a number of privileges to U.S. fishermen which were not reciprocated.

4. Amidst many different controversies, not the least of which was the entrance of Canada and the U.S. into World War I, an international joint commission consisting of Canada and the United States was formed to discuss and study the problems associated with the Pacific halibut and sockeye salmon fisheries (Thompson and Freeman 1930; Pacific Fisherman Yearbook 1924).

5. In the years of 1914 and 1915, overproduction of halibut forced the industry to take a new look at itself. The limitations of the storage capacity of halibut were evident: gluts due to a previous year's catch would keep prices depressed. A

closed season was suggested and implemented in 1921-1922 by the industry, without the help of any governmental agency. This was the first closed season of the halibut fishery.

6. The halibut fishery was unique in that both fishermen and vessel owners from inside and outside the halibut fishery had an active hand in the formation and implementation of the production control regulations, both in an official capacity with International Fisheries Commission (IFC) and, until World War II, from their own private efforts. High concentration of the major part of the halibut fleet in Seattle made the formation of an advisory board to IFC and its private regulations feasible for a long time. Many positive effects of this organization were apparent. They were in large part responsible for: voluntary tie-ups in the 1930s; staggered departures for different vessels; catch per man per trip limits and penalties; quality control checks at the vessel level; weight and grade checks at the fish auctions; and aggressive political pressuring of the IFC and at the market on behalf of both vessel owners and fishermen. Assistance and sympathy for conservation measures were also given, at least in one case, by a different fishing group.

7. As can be seen in Appendix I, various management techniques provided for by convention have been used by the IPHC to adjust the catch. However, side effects of certain management techniques manifested themselves in the fishing industry, particularly in distribution. Imposing of seasonal catch limits, size limits, gear restrictions, and closed areas are some of the most common techniques used. Other techniques such as sealing of gear and departure control, were abandoned because of the manpower it took to enforce them.

   Early in the regulated fishery the problem of incidental catch became a difficult topic. Several schemes were tried, from a lenient policy stance (allowed keeping incidental catch), to increasingly stringent measures (allowed keeping one pound of halibut for every seven pounds caught of the target species), to licensing an after-season incidental fishery, and finally, strict prohibition of any retention of halibut taken incidentally. An example of the difficult position in which resource managers are placed is the observation by one reviewer that even an increase in crabbing pressure brought on a significant amount of incidental halibut catch. These halibut, in many cases, are used for bait. It is suggested that the relatively recent interest in bottom fisheries with large trawl gear could lead to the demise of the halibut fishery.

8. Monitoring techniques used by the IPHC through the years are good examples of forethought and planning. The North Pacific Coast has been divided up into 60-mile statistical areas. Although the major areas have been changed several times as management needs required, the statistics provided by this management technique allow the IPHC to maintain consistently reliable data sets.

9. The Japanese first started exporting halibut to the United States in 1925. It is suspected that this halibut (850,000 pounds) was caught in Japan's coastal waters and was quickly depleting those stocks. Several subsequent shipments occurred. As Japan became more aggressive in the world fishing business, it made small sales to other countries, to Britain in particular. Early shipments were poorly handled and the fish did not sell well. In the late 1950s and early 1960s, the volume of sales of halibut to the U.S. and Britain suggested that Japan was violating abstention agreements in the Bering Sea by either keeping incidental catches or trawling for them specifically.

CHAPTER IV

THE HALIBUT RESOURCE

Geographical Distribution and Biological Aspects

There are two commercially important, true species of halibut (*Hippoglossus*) in the world: the Atlantic halibut (*Hippoglossus hippoglossus*) and Pacific halibut (*Hippoglossus stenolepis*). The Atlantic halibut fishery, historically more active because of European and new world fishing fleets, suffered severe over-exploitation, especially with the increased use of trawl nets for groundfish. As late as 1940, the U.S. fleet fished halibut as far south as Virginia and Delaware. But today, fishermen from this region do not engage in the fishery.

The Pacific halibut fishery had originally extended as far south as northern California. Today, there is little left of that southernmost fishery, as can be seen by the catch and landings statistics compiled by the International Pacific Halibut Commission (IPHC).

The halibut's life cycle is characterized by high fecundity (600,000 to 4,000,000 eggs per female), low survival between hatching and recruitment, and a long life span. Growth rates will vary with age and between stocks. The maximum recorded age of halibut is 42 years. Female sexual maturity is about 12 years. Fifty percent of recruitment is realized in the seven-to-11-year span, depending on the area and the sex. Among the major groundfish species listed in the North Pacific Fishery Management Council's *Fishery Management Plan for Groundfish*, only cod, with a roe of 800,000 eggs per average-sized gravid female could possibly exceed halibut in fecundity.

Halibut spawn in winter, from about November to March, and are usually found from depths of 10 to 250 fathoms. The general tendency of the fish to move to deeper water in the wintertime is the reason that halibut may be found through a great range of depth. Some halibut migrate extensively; a 2,000 mile migration has been recorded (Myhre 1978). Recruitment to the fishery covers a wide age range. A halibut of medium size (10 to 60 pounds), although commercially acceptable and comprising the bulk of the fishery, may be from seven to 18 years old. Halibut of the chicken size (5 to 10 pounds) are presumably even younger. Although chicken halibut are no longer permitted in the commercial catch, at one time they legally comprised a large portion of the catch. Although chicken halibut are illegal catch, it is not uncommon for them to be kept by crews for food.

The depletion of the halibut fishery can be attributable chiefly to man, according to historical records by the International Pacific Halibut Commission (IPHC). The Atlantic halibut fishery, one of the oldest in Europe, has faced a constant decline since the turn of the century. The extreme southern range of the Atlantic halibut was set by zoologists off the coast of Delaware, although it is doubtful that commercial quantities ever existed that far south. Most of the productive areas, at the time of IPHC's journal on the life history of the halibut, included the Barents Sea, Spitzbergen and Bear Island, the Norwegian Sea, Faeroe Islands Fishing Grounds, Iceland, West Greenland, and off Nova Scotia (Thompson and Van Cleve 1936). The southernmost regions where commercial catches were taken were the Gulf of Maine on the American side and the northwest coast of Scotland and Ireland. The depletion of the halibut resource in the North Atlantic is shown by comparisons of catch data for 1932 and 1976, obtained from the International Council for Exploration of the Sea (ICES) and International Commission of North Atlantic Fisheries. The catch in 1932, at 17,907.45 metric tons is compared with the 1976 North Atlantic catch of 6,147 metric tons, a decrease of some 66 percent from 1932.

The Pacific halibut fishery did not receive as much exposure to intensive fishing from as many different countries as did the Atlantic halibut fishery. In fact, until the early 1940s, the sole participants in the fishery were U.S. and Canadian fleets in the east, and Japan to the far west. As in the Atlantic halibut fishery, the distribution of halibut appears to be a function of temperature regime, with an optimum temperature being roughly from 3^{o} to 8^{o}C. This again delineates the major halibut fishing grounds historically as the interface between a warm northward moving current (the Japanese) and cold water masses. Within the wide-ranging distribution of halibut, different stocks are also evident. The IPHC has reported that there appears to be two allopatric stocks of halibut, roughly divided in range at Cape Spencer, Alaska (Thompson and Herrington 1930). However, the present view is that there is no clear demarcation at Cape Spencer, as was proposed earlier (Skud 1977a). Later in the IPHC's stock delineation work, it was suspected that, in some areas, there were two separate stocks making migrations with respect to depth. One stock returned from deep water in the early spring and summer, the other in late summer and fall. The effects of the environment (currents, storms, temperatures, salinity) affect growth of biomass, recruitment, and mortality of stocks. At equilibrium, each stock may have its own distinct population parameters for fecundity, growth rate, natural mortality, and recruitment.

Unlike the northern Atlantic, the northern reaches of the halibut fishery in the Pacific were not well known in 1936. The logistics involved in fishing the far reaches of the Bering Sea were not well worked out. Figure 6 shows the extent of the Pacific halibut resource as was reported by Thompson and Van Cleve (1936). Exploitation over a long period of time in a fishery is necessary to delineate the natural extent of the fishery in the absence of intensive fishery research. For example, the IPHC has used different management techniques to encourage fishermen to fish the Bering Sea in order to obtain an optimum distribution of exploitation and to obtain valuable stock data from the resource. This also brings up the important point that the extent of the areas fished must be taken into account when making intertemporal comparisons of catch. An excellent example of this applied to history is the area expansion of the halibut fishery. In the first years of the fishery, the area was quite localized and fish were abundant. As stocks

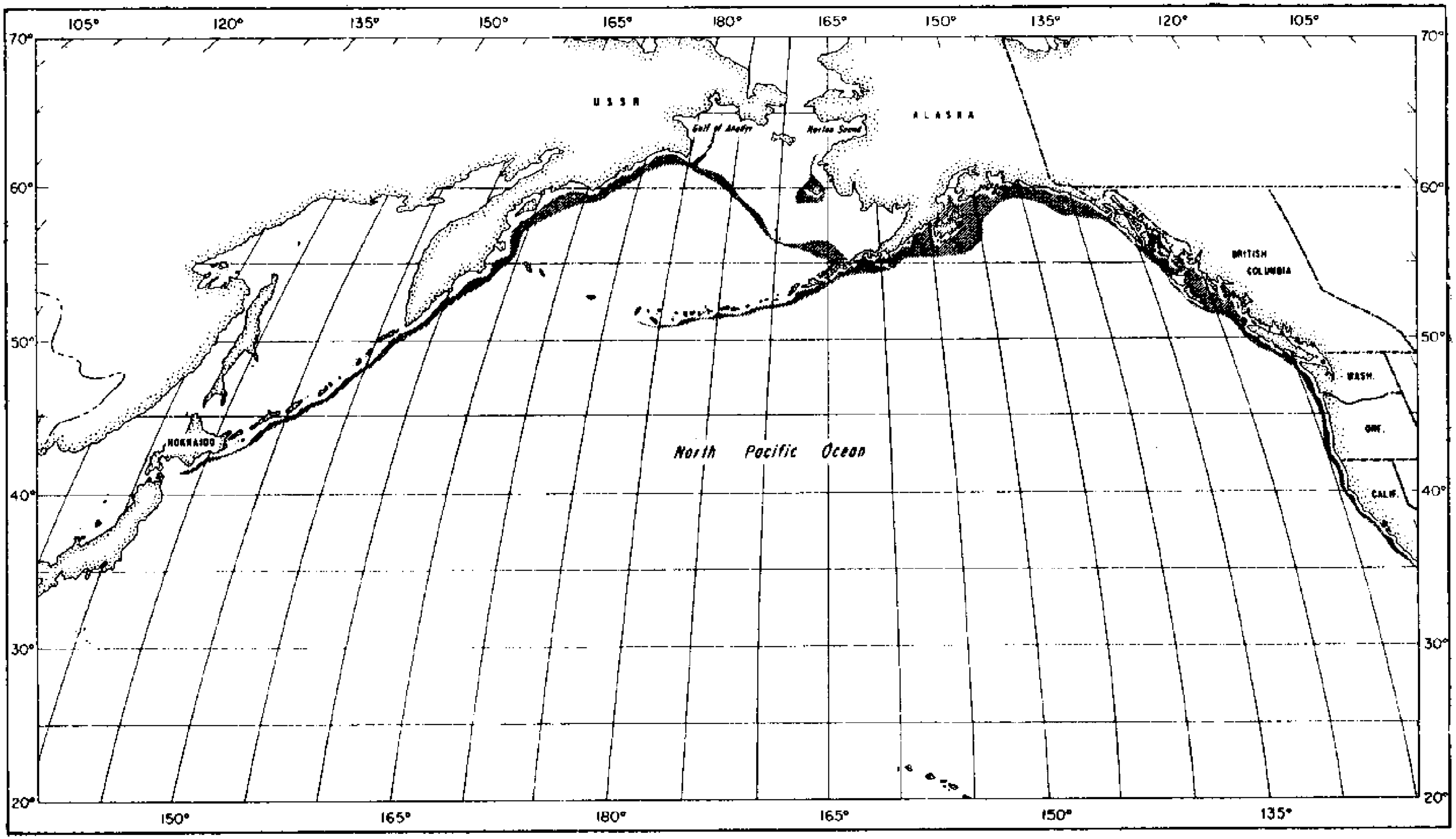


FIGURE 6. DISTRIBUTION OF PACIFIC HALIBUT. After Thompson and Van Cleve (1936).

were depleted, the fleet increased its range, thereby covering more area. The catches were phenomenal, but then, so were the technological improvements and ranges of the vessels.

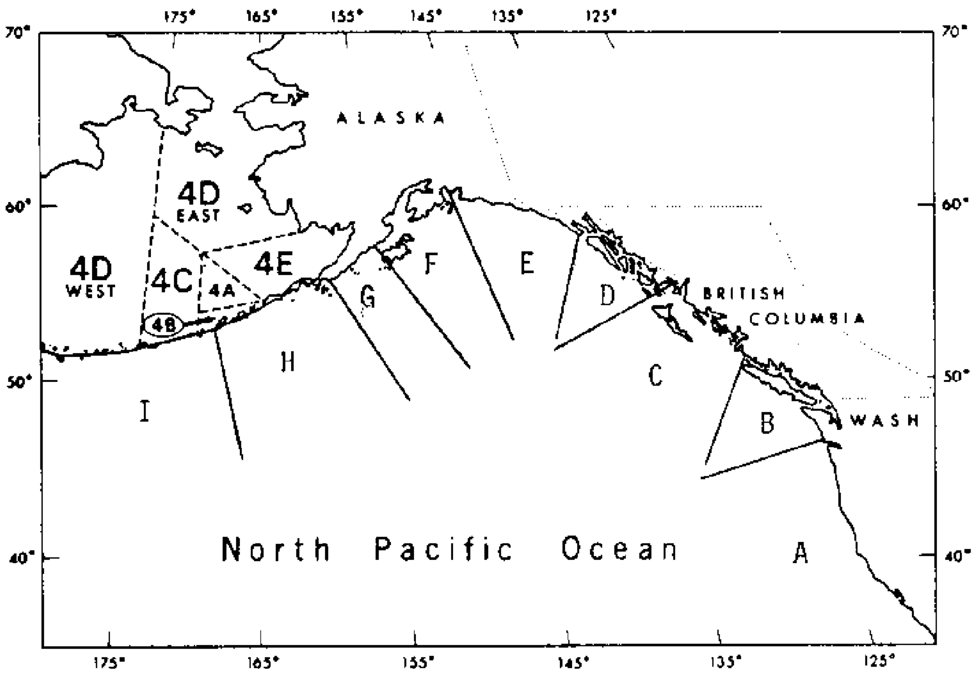
A similar comparison is made for the North Pacific (Figure 7) using metric tons (dressed weight) of halibut caught in INPFC (International North Pacific Fisheries Commission) and IPHC statistical areas. The figures shown are a minimum quantity, since they do not include illegal and incidental foreign catches, which are likely to be large (Appendix II). It is immediately apparent that the catch (live weight in metric tons) caught off the coast of Alaska far exceeds that taken in all the other areas of the Atlantic and Pacific combined (Table 38).

In summary, the Atlantic and Pacific halibut distributions possess several things in common. The southern ranges of each halibut fishery are well defined and were the first areas to become depleted. Atlantic and Pacific distributions seem to follow gyres of warm ocean currents that collide and, to some degree, mix with colder water from the arctic, thus creating a sub-arctic environment. Southern distributions of both Atlantic and Pacific halibut seem to end on the western part of the range more quickly than they do on the eastern part of the range. However, the fisheries of Alaska and the Bering Sea are much newer than the Scandanavian counterpart in the North Atlantic. And, Alaska is a major contributor to the world in the production of halibut, even though the halibut fishery's importance in Alaska relative to other fisheries has declined.

Maximum Sustainable Yield of Major World Stocks

The Atlantic

Several major difficulties arise when trying to establish the exploitation rate of halibut in the North Atlantic. One difficulty is conforming data derived from reporting activities of the International Council for Exploration of the Sea (ICES) and that of the International Council of North Atlantic Fisheries (Tables 39 and 40). Largely as a result of member countries lumping halibut with Greenland halibut and other flatfishes, the ICES data on Atlantic halibut cannot be identified. Compounding this problem is the fact that until 1963, ICES did not include catches of non-member countries in their fisheries statistics. Gulland (1971) makes the observation: if one assumes that the reported USSR catches from the Barents Sea, Norwegian Sea and Spitzbergen/Bear Island are mostly Greenland halibut, then the consistent catches of the Atlantic halibut recorded by ICES would be relatively small (6,630,376 pounds, dressed; about 4,000 tons, round), with no appreciable increases in this figure being possible. This figure, then, appears to be the nearest one can get to describing even a ballpark sustainable yield figure for the Northeast Atlantic under ICES data collection systems. However, it is doubtful that this figure is an accurate maximum sustainable yield (MSY) considering the unregulated nature of the Atlantic fishery (Myhre 1978).



	1932	1977
A. Columbia	524.25	25.4
B. Vancouver	1,207.17	233.15
C. Charlotte	7,390.23	2,115.35
D. South Eastern	4,666.40	1,526.79
E. Yakutat	3,497.24	1,194.76
F. Kodiak	6,583.64	2,724.73
G. Chirikof	2,360.05	869.99
H. Shumagin	589.41	637.30
I. Aleutian	...	182.80
Bering Sea		
4A	...	9.07
4B	...	122.47
4C	...	58.51
4D east	...	2.27
4D west	...	116.57
4E	...	...

FIGURE 7. A COMPARISON OF NOMINAL CATCH, IN METRIC TONS, BY AREA, 1932 TO 1977. Data taken from the International Pacific Halibut Commission reports.

TABLE 38

COMPARISON OF ALASKA'S RELATIVE IMPORTANCE WITH THE WORLD
IN THE CATCH OF HALIBUT INCLUDING JAPANESE AND RUSSIAN CATCH IN 1976
(In Metric Tons Live Weight[1])

	Alaska	Other North Pacific (Includes Japan, Russia and others)	North Atlantic	Total	Alaska Percent
1932[3]	22,363,136	16,511,884	17,907	56,782,020	39.8
1976	15,594,289	9,974,934[2]	6,947[2]	32,542,934	47.92

[1]Alaska and North Atlantic figures for 1932, as well as components of catch under other North Pacific, were taken from various IPHC statistical reports.

[2]Components of this total were taken from the 1976 FAO Yearbook of Fisheries Statistics.

[3]1932 was one year after one of the lowest catches in history for U. S. and Canada.

TABLE 39

NOMINAL CATCH OF HALIBUT FROM THE NORTHWEST ATLANTIC
FROM ICNAF SUB-AREAS BY YEAR
1952-1976[1]
(In Metric Tons Live Weight)

Year	Catch	Year	Catch	Year	Catch
1952	3,365	1961	5,843	1970	2,387
1953	3,857	1962	5,129	1971	2,491
1954	4,204	1963	4,247	1972	2,153
1955	4,222	1964	4,497	1973	2,145
1956	4,779	1965	4,041	1974	2,165
1957	6,311	1966	3,258	1975	2,137
1958	6,029	1967	3,754	1976	2,154
1959	6,391	1968	3,168		
1960	6,878	1969	2,633		

Source: International Commission of the North Atlantic Fisheries Bulletins, 1958 to 1976.

[1]Includes non-member catches.

TABLE 40

ESTIMATED POTENTIAL IN THE NORTHWEST ATLANTIC
BY ICNAF SUB-AREA, FOR HALIBUT AMERICAN
PLAICE AND GREENLAND HALIBUT
(In Thousand Metric Tons Round)

ICNAF Sub-Area	1	2	3	4	5	Total Metric Tons
Halibut[2]	1	+	2	3	+	7-10
American Plaice[3]	(X10)?	(X10)?	(100+)?[4]	(50+)?	(10)?	100-300
Greenland Halibut[5]	(20)?	(20)?	(20)	+	-	50-100

Source: Gulland (1971).

[1] Question marks indicate incomplete information on stocks. The term "+" represents a potential yield between 0 and 50 metric tons. All yields except for that footnoted by 2 are considered fully exploited as of 1971.

[2] Kohler (1967) suggests that, for the areas 3 and 4, the yields shown can only be obtained through special protection of small fish. The trawl fishery causes a high incidental mortality of small halibut.

[3] As of the 1971 writing by Gulland, larval data for American Plaice indicate a high abundance.

[4] This yield is based on a heavy fishery.

[5] Stocks may still be abundant in deep water.

The International Council of North Atlantic Fisheries (ICNAF) data, on the other hand, appear to be much better organized and more complete than the Northeast Atlantic counterpart, thus making it possible to not only list MSY figures by statistical sub-areas (Table 41), but also to compare these with plaice and Greenland halibut, two competitors on the market.

The Pacific

The Pacific halibut fishery from northern California to longitude 175° has been the subject of extensive research by the International Pacific Halibut Commission, whose management objective in the past has been to insure that a maximum sustainable yield would be achieved. The Commission established a comprehensive program of collecting catch, landings, and effort statistics through industry support. It conducted tagging experiments and other research to obtain estimates of important parameters of the population. Catch, landings, and effort data are available through IPHC. The catch figures are different from landings data. The catch, and consequently the effort and CPUE (catch per unit effort), must be associated with a location of catching. Landings, on the other hand, represent where the catch actually was sold. Further discussion of these and other problems with catch statistics are available in Appendix III.

Catch, effort, and CPUE were originally derived for each 60-mile statistical area. This breakdown enabled catch to be aggregated by state. However, some difficulty was encountered in obtaining CPUE by state because many of these values for the smaller statistical areas were originally arrived at by interpolation. If one country did not have satisfactory effort statistics, then the CPUE from the other country would be used. If neither country had satisfactory effort statistics, then the CPUE of an adjacent area would be chosen. When the effort and catch data were compiled to statewide areas and state statistical sections, the derived effort was used to make the aggregation. Although it is possible in general to make intra-country comparisons of catch per unit effort by state and statistical area, the use of interpolation in some of the areas will be difficult to interpret. Further distortions of CPUE estimates may come about as a result of faulty catch reporting in order to escape quotas and prolong seasons in more proximally located areas.

Maximum Sustainable Yield Estimates of IPHC

Chapman et al. (1962), developed maximum sustainable yield estimates using methods prepared by Schaefer (1954, 1957). A non-parametric method using catch and effort data, and a yield per recruit model, or dynamic pool model, were developed by the IPHC based on an earlier model by Beverton and Holt (1957). Since, in earlier studies (Thompson and Herrington 1930), the IPHC had concluded that there were two non-overlapping stocks of halibut, one in the southeast (Area 2) north of Cape Spencer, and one in the west, including the Bering Sea (Area 3), the maximum sustainable yields were calculated for each stock. For Area 2,

TABLE 41

NOMINAL CATCH OF HALIBUT UNADJUSTED FOR THE
PRESENCE OF GREENLAND HALIBUT BY YEAR AND ICES AREA
(In Metric Tons Round Weight)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
I - Barents Sea	1,342	1,244	1,494	2,694	24,083	1,781	1,346	235	257	84
IIa - Norwegian Sea	3,702	3,386	3,378	2,473	2,874	13,707	7,732	2,145	1,910	2,103
IIb - Spitzbergen and Bear Island	3,623	3,218	828	1,008	2,494	5,137	3,305	12	2	2
Va - Iceland Grounds	7,115	5,595	4,924	4,653	3,759	4,060	2,647	2,805	2,091	2,077
TOTAL	15,782	13,443	10,624	10,828	33,210	24,685	15,030	5,197	4,260	4,266

	1970	1971	1972	1973	1974	1975	1976	1977[1]
I - Barents Sea	85	99	87	87	62	38	42	13[2]
IIa - Norwegian Sea	1,825	1,534	1,356	1,552	1,368	1,185	1,064	---
IIb - Spitzbergen and Bear Island	61	5	4	7	23	17	1	5[2]
Va - Iceland Grounds	3,212	3,112	2,325	2,000	1,762	1,894	2,297	2,030
TOTAL	5,183	4,750	3,772	3,646	3,215	3,134	3,404	

Source: International Council for Exploration of the Sea (1978).

[1]Preliminary.

[2]Including divisions VII d and e.

the three estimates ranged between 31.4 and 33.0 million pounds. For Area 3, the Schaefer model was not used but the non-parametric and dynamic pool models yielded 38.1 million pounds and 36.0 million pounds, respectively.

Also, the wide range in catch per unit effort (≈ 117 to ≈ 120 lbs per skate in Area 2 and 95 to ≈ 136 lbs per skate in Area 3) reflects the divergence between estimates.

An interesting aspect of the IPHC's experience with management of the resource is that, just when it appeared that the management plans had finally paid off in bumper catches of halibut in the late 1950s and early 1960s (Figures 8, 9, and 10), the whole system seemed to start deteriorating despite all the efforts of the IPHC.

For Areas 1 and 2 (Figure 8), the peak in catch came in the early 1950s. In the face of a declining effort, catch per unit effort is inversely proportional to effort, as one would expect, up until 1950. From there on, effort vacillated, and both catch and catch per unit effort took a steady plunge.

For Area 3 (Figure 9), there was a gradual climb in yearly catch that peaked in the early 1960s and then fell. The recovery in the early 1970s seems to be correlated roughly to the increased U.S. interest in the ocean's resources and subsequent extension of the territorial seas and restriction of foreign fishing.

Area 4 (Figure 10), the Bering Sea, shows the catch skyrocketing in 1963, and then, by 1973, the lowest catch in 16 years was recorded, the first low being right at the beginning of the fishery in the mid-1950s.

In each of these three cases, however, it is hard to believe that the overall downward trends in the catch per unit effort and the catch are being caused solely by domestic pressure on the fishery in the form of simply the number of skates. Several alternative explanations may be appropriate:

1. The skate, the unit that is officially recognized as the accepted measure of effort in the halibut fishery, may be more efficiently used in recent years because of advances in boat and navigation equipment design. Investment of capital in time or labor-saving devices would have a tendency through time to make the skate more efficient, and would therefore be, in effect, a different measure of effort than before. Therefore, the time and effort expended may, in fact, have been gradually underestimated.

2. The use of trawls in regions where halibut are abundant, and the incidental catch of halibut in smaller age classes from the late 1940s and early 1950s by both domestic and foreign trawlers, are showing up in the late 1960s and early 1970s as reduced catch despite decreases in domestic effort.

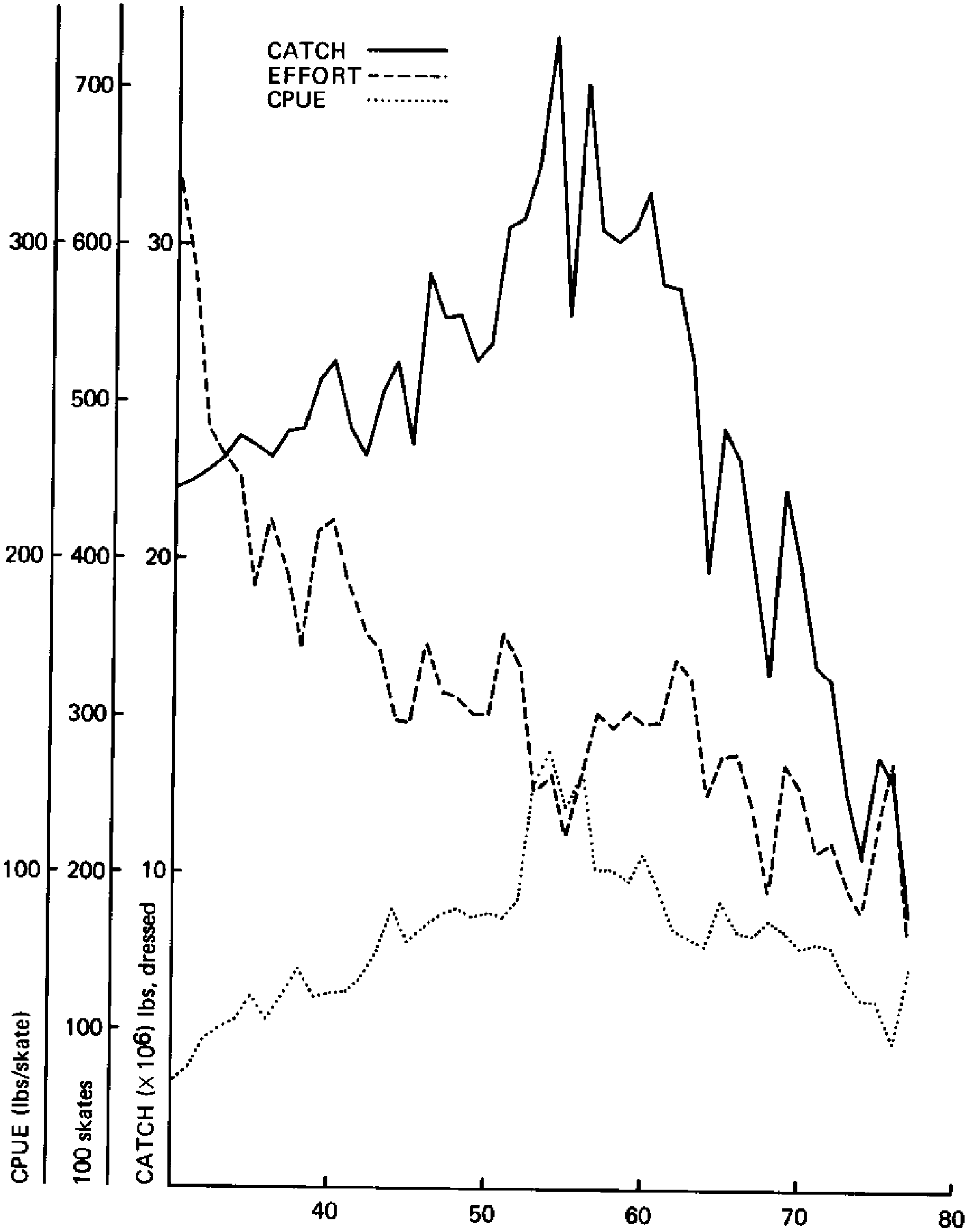


FIGURE 8. CATCH, EFFORT, AND CATCH PER UNIT EFFORT FROM 1930 TO 1977 FOR IPHC AREAS 1 AND 2

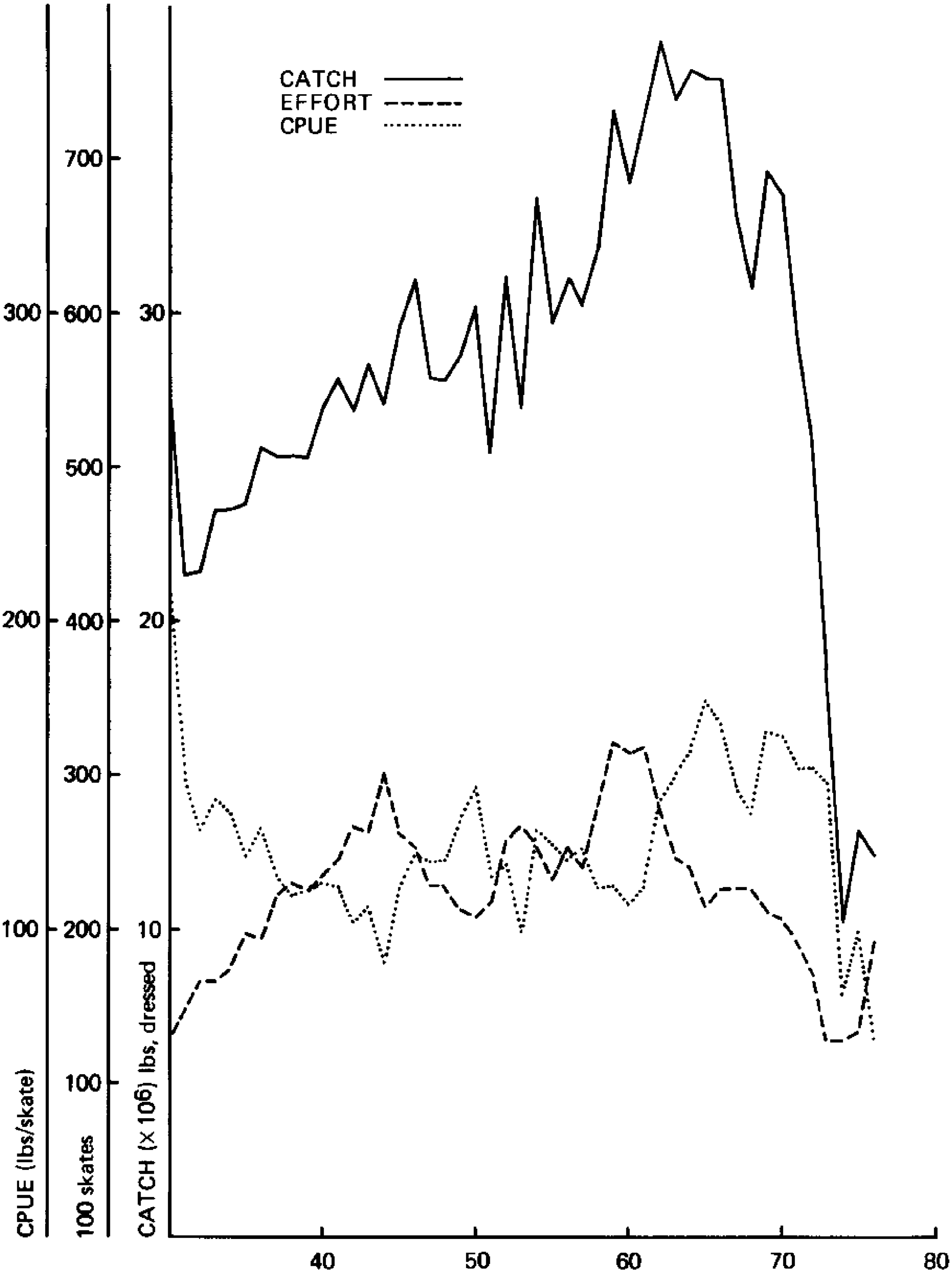


FIGURE 9. CATCH, EFFORT, AND CATCH PER UNIT EFFORT FROM 1930 TO 1977 FOR IPHC AREA 3

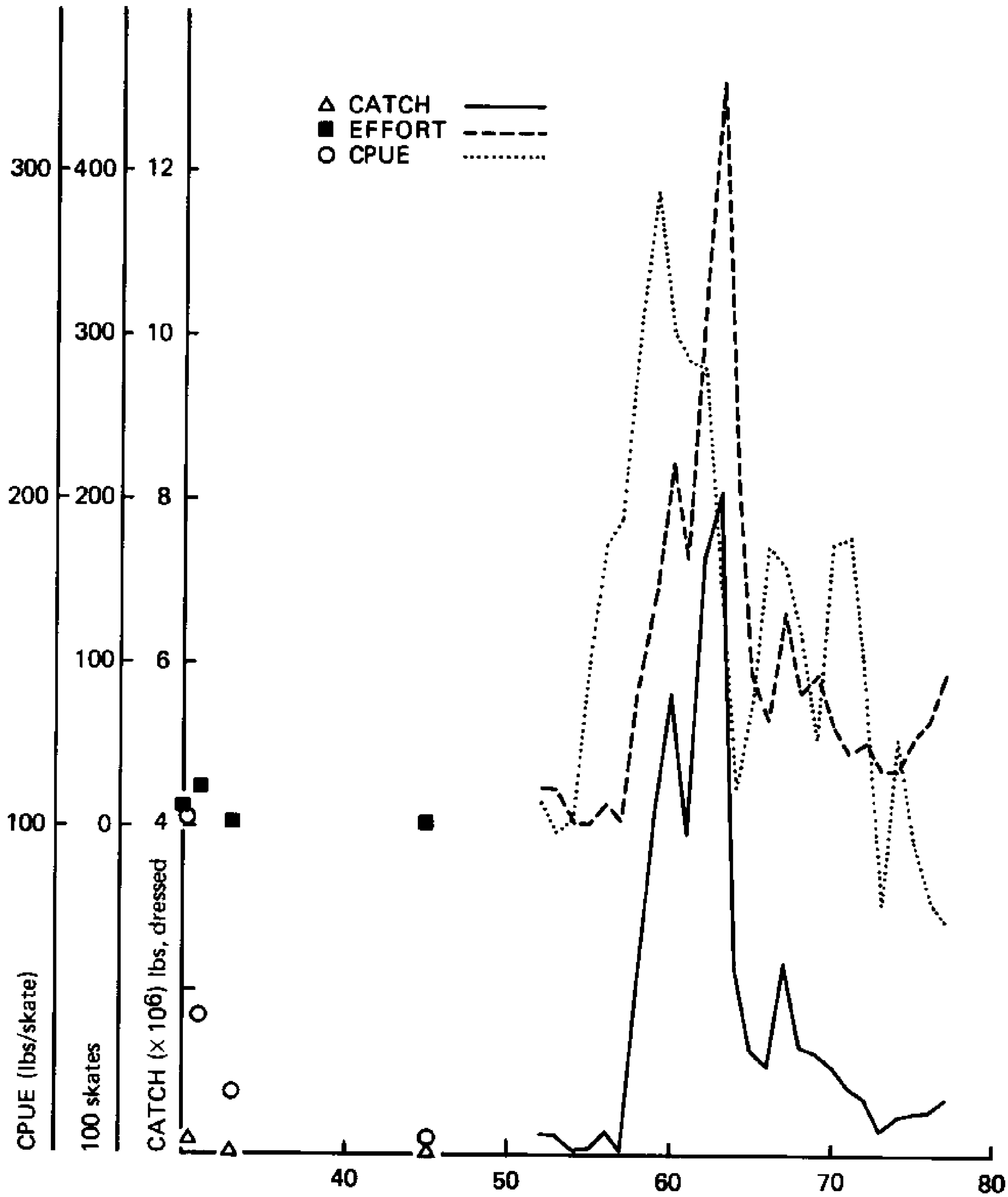


FIGURE 10. CATCH, EFFORT, AND CATCH PER UNIT EFFORT FROM 1930 TO 1977 FOR IPHC AREA 4, THE BERING SEA (see Appendix I.)

3. Large overages in catch quotas occurred in Areas 2 and 3 in the late 1950s and early 1960s. The catch in later years may have suffered from an adverse impact arising from these activities.

Each of these three problems seem to be related to eroding management power of the IPHC, despite an obvious success in controlling over-exploitation in previous years by the adoption of a sound biological management program. Some of the causes of this management erosion have been outlined by Skud (1976):

1. Gear and fishing technology improvements in other fisheries impose externalities on the halibut fishery in the form of incidental catches, which are difficult to discourage (Hoag 1971 and 1975). There has been no viable management answer to this problem outside of area and time closure, plus requirements that incidentally caught halibut be released. The latter has questionable management value because of high mortality of caught and released halibut (Hoag and French 1976).

2. The method that the IPHC must use to change management plans is relatively slow and cumbersome. Because the Commission is an international one, management change involves heads of state rather than autonomous decisions by the fisheries managers. This limits the IPHC to long run planning. Although it has been reported that, in general, there may not have been many cases where extended management power for emergencies would be needed (Skud 1976), the need for that option becomes increasingly clear.

3. The IPHC has been forced to place an increased reliance on a sometimes disinterested enforcement arm, or those charged with assisting with enforcement have remained inactive.

4. Even in revised conventions between Canada and the United States, the jurisdiction of IPHC is still unclear. And, in some cases the authority of the International North Pacific Fisheries Commission has pervaded that of the IPHC in the Bering Sea.

It appears that the management problems encountered recently by the IPHC may not be necessarily based on their management objectives, but on occurrences in the fishery that were exogenous to the management model. In this respect the problems encountered by the IPHC is no different from that of any established management agency that is charged with monitoring resource use. It can be inferred, then, that any management program, based on something other than an MSY objective, would likely encounter the same kind of erosion of management control simply because of the dynamic nature of private enterprise. This suggests that efficient mechanisms for management model change is as important as management models themselves. It is, therefore, not entirely fair to attribute IPHC's difficulties in recent years to their management objectives.

Neither should outdated management objectives (which can be easily changed within the existing framework of data collection) be cited as a cause for abolishing the convention or the Commission.

World Resources Compared to the U.S. Fishery

World Catch

Supply data for the world were reported from the earliest available data, using values of the Yearbook of Fisheries Statistics put out by the FAO (see Appendix V). The Scandinavian countries, Canada, United States, United Kingdom, and Benelux countries, and the Federal Republic of Germany have records that extend back to 1953. Japan and the Soviet Union either did not make data available, or combined their halibut data with other flatfishes, or mixed two or more species of halibut in with the catch data thereby making it impossible to discuss the species. From 1953 to 1957, most entries by country were simply classified as "halibut" with exception of Norway, the United States, and Canada, which did show the true halibuts and Greenland halibut separately. Depending on how other countries were managed and what their previous production was, those quantities that were called "halibut" were placed in the Atlantic halibut group.

For years previous to 1969, all figures were in thousand metric tons; from 1970 to 1975, the figures are in metric tons. The statistics are reported by the FAO in a way that makes it difficult to determine exact quantities that were caught by each country. The symbolic system used by the FAO makes it possible to tell the catch to the nearest 100 metric tons. The use of the symbol 0.0 or 00 signifies a quantity greater than 0 and less than 50 metric tons. The symbol 0 signifies a quantity greater than 0 but less than 1/2 metric ton. A dash signifies nil or no catch, and an elipse (three dots) means that there may have been catch but they couldn't get the data. It becomes readily apparent from Appendix V that Alaska's catch of Pacific halibut reported by Canadian and American fisheries is important when compared to the catch of the rest of the world.

Greenland halibut (Reinhardtius hippoglossoides) has been presented in Appendix V, not only to offer volume of supply comparisons with the halibut, but also to measure the effect of the importation of their species on the retail (and consequently the exvessel and wholesale) price of all halibut during the time when it had enjoyed unrestricted entry into the United States as "Greenland halibut" or "halibut" from 1960 to 1967.

Foreign Sources of Supply to U.S.

The United States imported 7,508 million pounds of halibut in 1977 (product weight), according to the most recent Bureau of Census figures (Tables 42 and 43). Of this, Canada remained the principal exporter of halibut in fresh/frozen whole category, followed by Japan. However, Japan led Canada in exporting halibut fillets, followed by Iceland, and

TABLE 42

U.S. IMPORTS OF FRESH CHILLED OR FROZEN HALIBUT NOT SCALED: WHOLE OR BEHEADED[1]

Year	Canada Quantity	Canada Value	Japan Quantity	Japan Value	Norway Quantity	Norway Value	Greenland[2] Quantity	Greenland[2] Value	Other Quantity	Other Value	Total Quantity	Total Value	Comments
1977	5,368,947	7,989,132	47,782	58,551					490,507	212,101	5,907,236	8,259,784	13, 8
1976	5,420,736	7,462,000	1,764,327	2,334,000					215,075	145,000	3,840,138	9,941,000	13
1975	6,947,604	7,307,000	827,316	689,000					180,680	33,000	7,955,600	8,029,000	13
1974	4,415,991	4,469,000	826,009	667,000					114,906	58,000	5,356,906	5,194,000	13
1973	10,472,035	8,543,909	2,052,084	1,518,977					95,038	54,920	12,619,157	10,117,806	3, 5, 8, 10
1972	12,736,286	8,521,102	3,888,374	2,232,821					106,483	38,047	16,731,143	10,791,970	8, 9, 13
1971	19,745,747	8,118,090	66,500	32,514	62,598	38,930			96,230	38,335	19,971,075	8,227,869	3, 6, 8, 9, 10
1970	18,130,811	8,086,387	55,000	27,327					27,361	10,115	18,213,172	8,123,829	3, 4
1969	19,933,591	8,489,005	102,977	50,306	12,723	6,960			44,062	17,036	20,093,353	8,563,307	3, 4, 11
1968	17,836,290	5,552,653	180,115	40,410	51,125	28,085			14,884	5,489	18,082,414	5,626,637	4, 5, 9, 11
1967	15,430,171	4,781,430	68,290	22,111	26,585	14,725	2,508	537	39,488	18,072	15,567,042	4,836,875	4, 5, 11, 12
1966	19,420,758	7,496,909	19,073	8,016	22,035	13,397	3,390	644	30,390	11,914	19,495,646	7,530,880	8, 11
1965	21,450,912	7,405,610	5,566 / 22,112*	2,330 / 8,182*	134,073	53,936	10,044	10,044	39,464	36,507	21,653,171	7,514,509	4, 5, 7, 13
1964	22,303,093	6,125,948	138,441	36,176	114,465	45,795	4,325	1,384			22,560,324	6,209,303	
1963	3,923,167	1,157,157	15,000	3,025	154,932	64,331	14,526	4,464	7,042	1,620	4,114,667	1,230,597	8
1962	23,345,762 / 2,671*	7,790,760 / 615*	394,164	107,260	807,324	295,591	26,318	7,059	1,102	220	24,777,341	8,201,505	4, 5, 8,

Source: U.S. Department of Census, Imports for Consumption by Year.

[1]From 1974 on, some exporting countries cannot be isolated. From 1973 back, countries contributing to the "other" category are coded in the comments column: Iceland (3); Miguel (4); Denmark (5); Australia (6); Poland (7); Mexico (8); Netherlands (9); United Kingdom (10); W. Germany (11); Korea (12); Unknown (13). All values are FAS (see text). Figures for 1977 up to October were taken from U.S. General Imports which have historically matched halibut imports for consumption.

[2]Imports from Greenland may include turbot.

*Numbers are from points of shipment: Origin unknown.

TABLE 43

HALIBUT FILLETS AND OTHER PROCESSED FORMS,
FRESH, CHILLED, AND FROZEN,
IMPORTED BY YEAR FOR U.S. CONSUMPTION[1]

Year	Canada		Iceland		Japan		Norway	
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
1977	206,449	394,725	287,878	473,262	1,094,200	1,982,088		
1976	224,912	364,000	329,994	381,000	2,441,840	3,907,000		
1975	101,530	180,000	142,356	157,000	4,230,337	5,508,000		
1974	240,111	268,000	201,211	146,000	3,177,670	2,899,000		
1973	362,422	519,844	250,881	166,966	8,011,033	7,325,811	23,985	17,710
1972	563,627	657,001	301,706	204,629	11,656,669	7,258,941		
1971	1,738,359	1,467,585	182,854	126,626	3,693,955	1,874,473		
1970	1,718,737	1,472,918	251,910	177,441	4,516,868	2,325,284	331	265
1969	2,870,811	2,162,618	174,676	100,939	4,238,241	2,077,826	1,090,850	214,034
1968	6,574,077	2,871,626	211,116	128,821	3,822,188	1,312,514	229,340	56,576
1967	6,242,239	2,457,220	115,392	77,312	1,948,819	818,969		
1966	3,316,266	2,455,082	134,772	66,645	2,051,083	1,054,941		
1965	3,448,161	2,455,082	131,112	60,313	2,232,257	1,084,666	99,680	44,866
1964	3,075,407	1,744,964	121,380	55,836	2,224,001	775,856	28,491	13,141
1963	975,771	567,803	27,804	12,790	848,868	284,555		
1962	2,406,297	1,549,636	281,776	119,782	4,335,213	1,722,799	39,349	16,389

TABLE 43 (Continued)

Year	W. Germany		Other		Greenland		Total		Comments
	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	
1977			12,408	7,653			1,600,935	2,857,728	19
1976			46,674	64,000			3,043,430	4,716,000	19
1975			91,033	31,000			4,565,256	5,875,000	19
1974			16,187	13,000			3,635,179	3,326,000	19
1973			173,937	116,582			8,822,258	8,146,913	6, 14, 15, 16
1972			226,861	90,931			12,748,863	8,211,502	13, 14, 15, 16, 17
1971			134,229	51,771			5,749,397	3,520,455	2, 4, 5, 7, 6, 14
1970			12,895	5,604			6,500,741	3,981,512	18, 6, 15
1969	23,388	8,564	49,721	28,833			8,447,687	4,592,814	3, 6, 16
1968	15,204	3,041	44,500	18,451	43,188	10,365	10,939,613	4,401,394	8, 14, 11, 6
1967	6,426	4,828	18,030	6,878	45,869	13,203	8,376,775	3,378,410	12, 15
1966	17,000	5,976			179,888	46,695	5,699,009	3,078,532	
1965			5,952	2,333	24,792	5,840	5,941,954	3,653,100	12
1964	35,850	7,440	14,976	5,518	68,736	16,771	5,568,841	2,619,526	12, 9, 11, 6
1963	48,904	11,124	6,716	2,286			1,908,063	878,558	12, 13, 19
1962	71,715	19,908	34,768	17,058			7,169,028	3,445,572	12, 10, 11, 19

Source: U.S. Department of Census, Imports for Consumption by Year.

This data includes the imports of halibut from Greenland, which may in fact be turbot. Fillet statistics prior to 1964 include salmon fillets estimated at 25 percent of the total weight shown. Other countries were reported as having exported halibut to the U.S. These countries are coded by the following numbers which are included in the "comments" column where data was applicable: Venezuela (2); New Zealand (3); Finland (4); Spain (5); Taiwan (6); Greece (7); India (8); Guatemala (9); Belgium (10); France (11); Miquel (12); Korea (republic) (13); Denmark (14); United Kingdom (15); Netherlands (16); Poland (17); Mexico (18); Unknown (19). Figures for 1977 up to October were taken from U.S. General Import Statistics, which have historically matched halibut imports for consumption. Imports for consumption by country are available from the Bureau of the Census from the present back to 1947. In addition to imports specifically labelled as "halibut", Greenland also exported a large number of "flatfish" fillets and blocks not included here.

then Canada. It is interesting to note that, in previous years, Japan exported large quantities of halibut to the United States in both whole and fillet form. Yet, when P.L. 94-265 came into effect, in March of 1977, the amounts imported from Japan dropped drastically; signifying, perhaps, that the increased enforcement activities of the United States in maintaining the new act has made it difficult for any breach in catch laws to occur. Although it is much too early to say that this is definitely the case from this data, it would seem that this is a possibility, and would indicate an increased effectiveness in the IPHC's proposed conservation measures.

Domestic Sources of Supply

Since the North Atlantic halibut fishery is almost economically dead, the only question remaining is, what percentage of the total catch may be attributed to Alaska? The figures for 1976 put out by the IPHC suggest that Alaska represents at least 97 percent of the catch and 93 percent of the landings in the United States, including the North Atlantic. This is ample evidence to support the view that the industry of the United States stands or falls on the success of the halibut season in Alaska. Despite this obvious importance in the world catch, the United States has not reported exports to other countries in historical data. This suggests that any exports that do occur are negligible. The most consistent world supplier seems to be Canada, who has made heavy sales both to the United States and Great Britain. One exception to this is in 1977, when Japan reportedly made a large purchase of halibut, between two and four million pounds (Food Fish Market Review and Outlook, February 1978). However, these figures seem to be high when compared to the 1977 catch figures for the United States and the import data, and no mention is made of this export in the annual review of trade with Japan in the Pacific Packers Report (Benefiel 1977).

CHAPTER V

HARVESTING AND PROCESSING OF HALIBUT

Introduction

The Harvesting Sector

The fishermen's search, transportation, maintenance and keeping costs, plus the opportunity cost of running time to and from fishing areas determines product supply. The availability of price information, coupled with a general scarcity of the halibut resource seems to have changed the market climate between buyer and seller. The short-run supply for a single fisherman could be depicted as vertical, in much the same manner as an individual farmer's supply schedule in the very short run. This means that the single fisherman would be a price taker. However, in the halibut fishery today, a situation exists where processors must tacitly compete for the limited supply of halibut. The halibut fisherman may now exert a considerable amount of bargaining power, even though in the aggregate, the total supply may indeed be constrained because of quotas.

The relationship of fishing capacity to processing capacity plays a major role in the determination of the way each player of the market views his counterpart. In spite of the fact that in places like Kodiak, 85 percent of the catch is being landed by the traditional halibut schooner, the trend in halibut vessels has been toward smaller, more versatile and local vessels owned by independent fishermen (Myhre 1978), in response to the recent low levels of halibut catch and the subsequent need for diversification. However, processors deal in plants and holding facilities that extend far into the time horizon, and these plants are also based on the same low-volume fishery. In periods at the very beginning of the fishery, plant planning may be based on a smaller diversity of species and focused on production in the short run. However, the basic management problem in the mature fishery is one of maintaining a steady supply of raw product to maintain full capacity in the long run for both fishing and processing sectors. To accomplish this management objective, the classical fisheries and economic models are brought together to form the basis of modern fisheries management. A theoretical discussion of this "bio-economic" model appears in Appendix VI. A discussion of this model is particularly appropriate at this point, since one of the first fisheries to be discussed in this manner was the halibut fishery.

The Processing Sector

Processors and cold storage managers face their own cost structures which, in part, are based on cost structures of the fishermen through the price of the raw product but also include a number of other cost items. One reviewer of this manuscript in the summer of 1978, offered the following estimates of variable cost:

1.	Price of fish (a) Paid to fishermen (b) Raw fish tax	1.50/lb.
2.	Wages	.05/lb.
3.	Plant overhead	.10/lb.
4.	Shipping to Seattle	.04/lb.
5.	Cold storage costs (a) Unloading (b) Storing (c) Reloading to buyer	.10/lb.
6.	Shipping (the buyer of frozen product usually does not pay shipping to a final destination--the seller does)	.03/lb.
	Total cost without consideration for further processing like steaking, fletching, or individual packaging	$1.82/lb.

It can be seen that, at the cold storage level, holding time is directly translated into refrigeration costs. The tendency of the consumer to want prepackaged portions of boneless, skinless, easy-to-cook fish not only has become evident, but is also a major selling feature of many fish products (Gillespie 1977): this adds to the cost of the fish product. Transportation costs become an important consideration in the movement of the frozen product. For a fresh product that is flown to distant fish markets, the higher costs of air transport can become an overriding factor in the pricing of that product.

The final product is different from the original raw product because of the treatment it has undergone, its location, and its availability to consumers over the year. Once the product is frozen, glazed and stored, it takes on another product form, entirely different from its form at sea or its form at the dock. The fish is storable, enabling it to be traded over time. Although its product life is extended, it falls victim to other problems, such as dehydration (freezer burn) or oxidation.

A large amount of the product is usually aggregated in the freezer, but buyers are limited because of the bulk of the items for sale. The large size of the halibut further discourages individual small sales.

The length of holding determines the profit the processor can make. A point of diminishing returns occurs when the opportunity cost of using the space for that product instead of another exceeds the real or expected price increases over the holding period. It will pay to store as long as the price gain in the season permits a price that meets or exceeds the total intertemporal per-unit storage cost. Since halibut, as well as other fish, accrue a scarcity premium in the off-season, it will pay the whole fishery to develop a year-round market that has only modest price fluctuations rather than a highly seasonal "boom or bust" market. This is the crux of the cold storage business.

One major indicator of supply at the processor level is the cold storage holdings by month. The imposition of seasons and quotas and their length and magnitude determines the general outlook of the cold storage inventory. The shorter the season becomes, the more pronounced inventory oscillations seem to become. Bad previous years tend to drive inventories down in the following year. Good years tend to keep the inventories in a glutted condition the following year. Yearly halibut situation reports in Pacific Fisherman suggest that strong retail prices in lean years carried over to a good year of catch success will cause a glut in the inventory and drive down exvessel prices in the existing year. In other words, there are considerable lagged effects that simultaneously affect inventory and prices.

Harvesting Technology

Overview

The longline has been the basic method of fishing for halibut since the fishery's inception. Technological improvements have not been so much directed at radical new methods of fishing since the International Pacific Halibut Commission (IPHC) restricts the type of gear used. Rather, improvements have focused on style and materials used in longlining, design of deck and storage facilities for versatility in many fisheries, and the increased use of electronic fishing aids. Some of the improvements, although tangential to improvements in the actual longline gear, have increased efficiency by requiring less manpower and time and have left the boat owner free to become versatile in several fisheries. The versatility is reflected in today's boat and equipment styles.

Types of Gear

Skate. The gear used as a unit of effort in catch statistics by the International Pacific Halibut Commission is the skate. This consists of a small groundline of manila (favored in the past) or nylon (popular today) 5/16 to 1/4 inch in diameter, and about 300 fathoms (1,800 feet) long, with each end spliced onto itself to form a loop.

Other forms of connection are used. The braid of the rope is an important feature in determining the success of hand or automatic coiling, and must not be too limp or stiff for this procedure (Browning 1974, p. 229). The use of stainless steel, or rope that uses wire braids, finds a limited use in the "snap-on" system. The gangings are lengths of lighter braided nylon line four to five feet long bound to the groundline by means of a becket loop, which is constructed by passing a loop of braided nylon through one of the warps of the groundline. The hook most used for halibut is a 12/0 or 13/0 (Browning 1974, p. 231).

Through different periods of history, the distance between these gangings have varied, based on the fishing industry's perception of their effectiveness. Although a decrease in the spacing of hooks tends to increase incidence of catch (Skud 1972, Appendix VII), the marginal increase in catch must be weighed against the extra labor time and bait cost of the closer spacing. The tendency in recent years has been to increase the distance between hooks, use less bait, and increase fishing speed. As a result, skate gear usually has a spacing of 18 to 26 feet. Other sources suggest that, for lower fish densities, 28 to 36 feet would be advisable (Alex 1978). The line is coiled by hand or machine such that the sections that do have gangings on them are exposed for easy repair and indexing. The hooked bait is placed in the middle of the skate and the whole skate is then bound by a canvas retainer (Browning 1974).

Tub Gear. The tub arrangement is a slight variation on skate gear, where the hooks are placed along the edge of the tub on the outside, thus making baiting and hook repair easier. A difficulty of tub gear is that it needs more attention when setting and is difficult to untangle if dropped. Sometimes, tubs are lost overboard during the setting process (Alex 1978).

Snap-on Gear. A recent development in halibut gear that has induced large numbers of the "mosquito fleet" to move into the halibut fishery is the use of "snap-on" gear introduced about 20 years ago (Figure 11). Hailed by some as being space-saving, versatile and, at the same time, extremely dangerous, snap-on gear is a mixed blessing to smaller vessels in the halibut fishery. Snap-on gear has also changed the concept of effort and has made easy identification of the halibut fleet difficult because of the entry of boats temporarily outfitted for halibut fishing. These vessels switch from other fisheries, principally salmon gill netting, to halibut longlining.

The longline snap-on gear can usually be used with a regular gillnet drum. The gangings and hooks are placed on separate racks, repaired and baited. The snap-on ganging is a relatively simple device that may be spaced anywhere on the groundline. Some of the advantages of snap-on gear are variability of spacing the gangings, the elimination of hand-coiled lines, reduced space required for the longline operations, ease of baiting and repairing hooks and gangings. An important advantage is that deck work can be performed by at least one less man, low cost of entry into the fishery, and greater adaptability to fishery gear used on other fisheries (Browning 1974, p. 229).

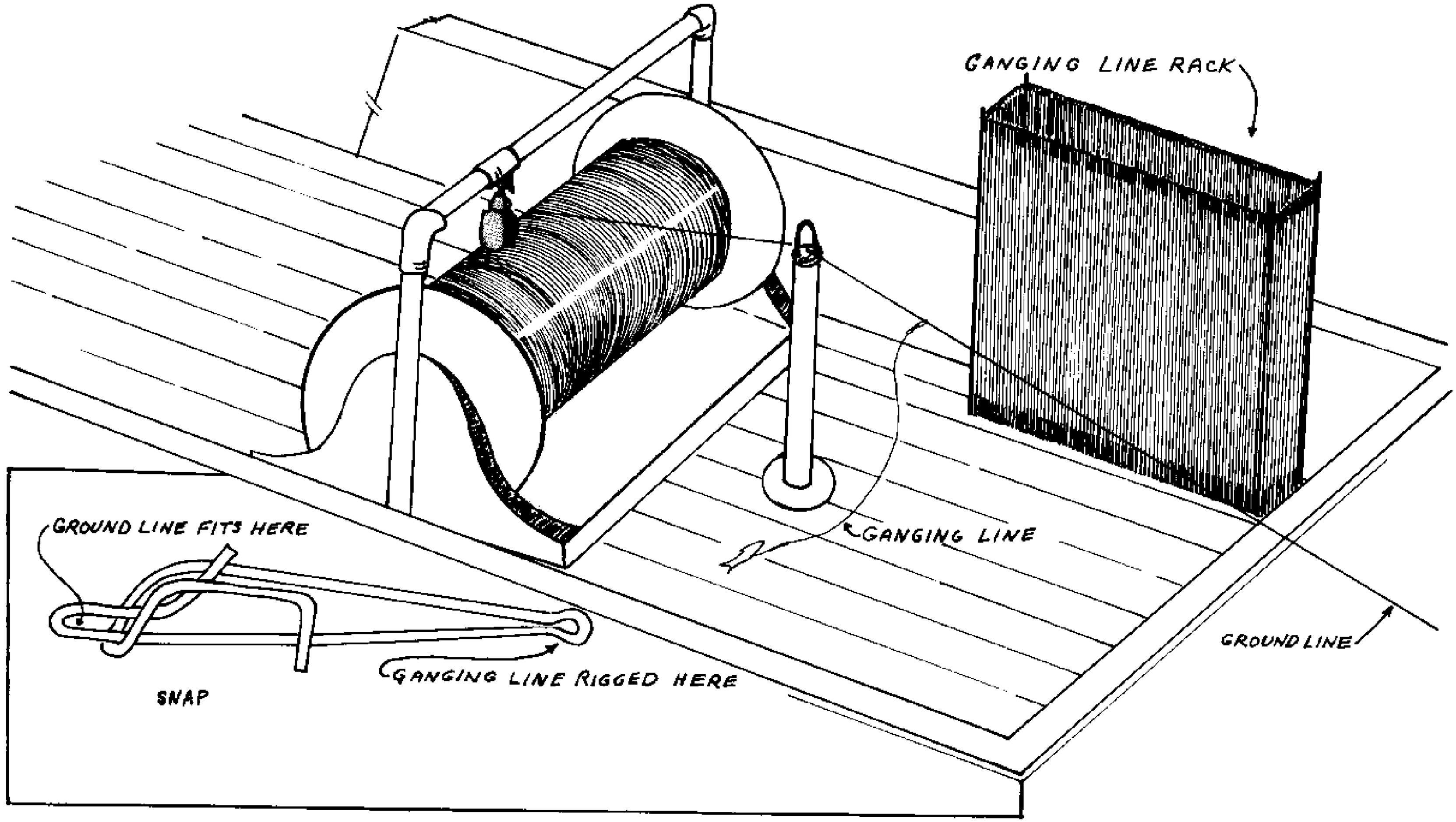


FIGURE 11. DECK LAYOUT USING SNAP-ON LONGLINE GEAR WITH INSERT OF A SNAP

Setting and Hauling Gear

Skates are connected together to form a longline, which may reach a distance of three nautical miles (Browning 1974, p. 226). The ends of these long pieces of line are fixed to a chain and anchor which may be as heavy as 50 pounds (Figure 12). This whole system is connected to a large float (usually a plastic globe of international orange with an indicator buoy side-tied). This indicator buoy usually consists of a long bamboo or aluminum pole with a red or international orange flag attached and a battery operated light atop the pole (Browning 1974, p. 228). That part of the pole that is below the buoy is usually counter-balanced by a sash weight to keep it upright.

With the demise of dory fishing for halibut in the North Pacific in 1935 as a result of IPHC regulations, different methods of paying out the line were experimented with. The original system of flipping out the line with a stick was quite effective for the small, slow-moving dory, but could have disasterous results on a fast-moving, large ship. Throughout the history of the longline fishery, the major source of injuries has come from errant hooks flying out of or back into boats. The justifiable desire of the fishermen to minimize these unpleasant occurrences led to the invention of the metal-lined "chute" (Figure 13), and allowed the fishermen to keep a safe distance through most of the setting operation (Thompson and Freeman 1930; Browning 1974, p. 232).

Setting a string of gear appears to be as varied as the fishermen in the business, but some methods seem to be in wide use. Loran navigational systems are useful in positioning and relocating gear. Occasionally gear may even be set along gridlines. This practice is especially useful out of sight of land or in bad weather. Berthing, or placing longlines in parallel rows at distances of up to three nautical miles, assures an adequate coverage of an area (Browning 1974, p. 6.232) However, it is suggested by other sources that berthing using Loran systems is, at best, only one of many methods and strategies used by halibut fisheries. Careful log records in conjunction with Loran, depth soundings, temperature data, and catch data are also used to make decisions on where to set gear. Tidal activity is also a major consideration in setting gear.

The soak time, or the time that the gear is left in the water, may be as short as four to six hours, or as long as 20 to 30 hours. Again, it has been shown that, in general, the longer the soak, the higher the catch (Appendix VII). However, and again with consideration of economic matters, the potential gains foregone by waiting must be weighed against the marginal gains one expects to make during the extra soak time. Also, long soak times may simply be impractical in some areas, where the danger of the bait and catch being consumed by crustaceans is great. The haul is more difficult and hazardous than the setting of the gear because it is important that the vessel is placed correctly over the set line to avoid chafing and fouling of the ground-line. This may be a dangerous task in rough weather or strong currents. In addition, the crew is usually working at a fast rate and, at the same time, they are required to be precise. Rail rollers, (Figure 13) the guide through which the longline passes, is not usually a permanent fixture, but is

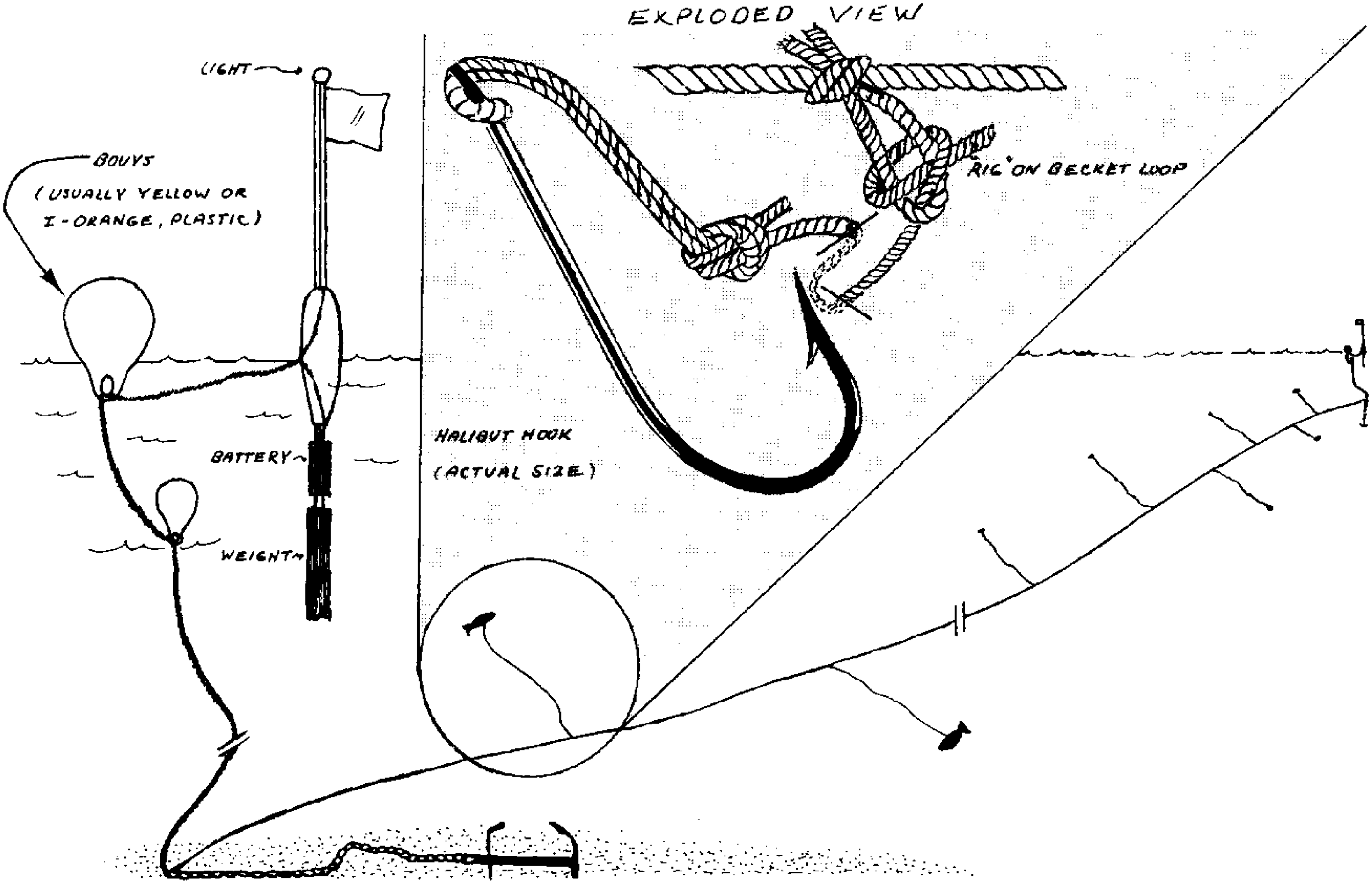


FIGURE 12. HALIBUT LONGLINE AND BUOY. ENLARGED DIAGRAM SHOWS THE GROUNDLINE RIG WITH A BECKET LOOP AND HALIBUT HOOK ATTACHED TO THE GANGING.

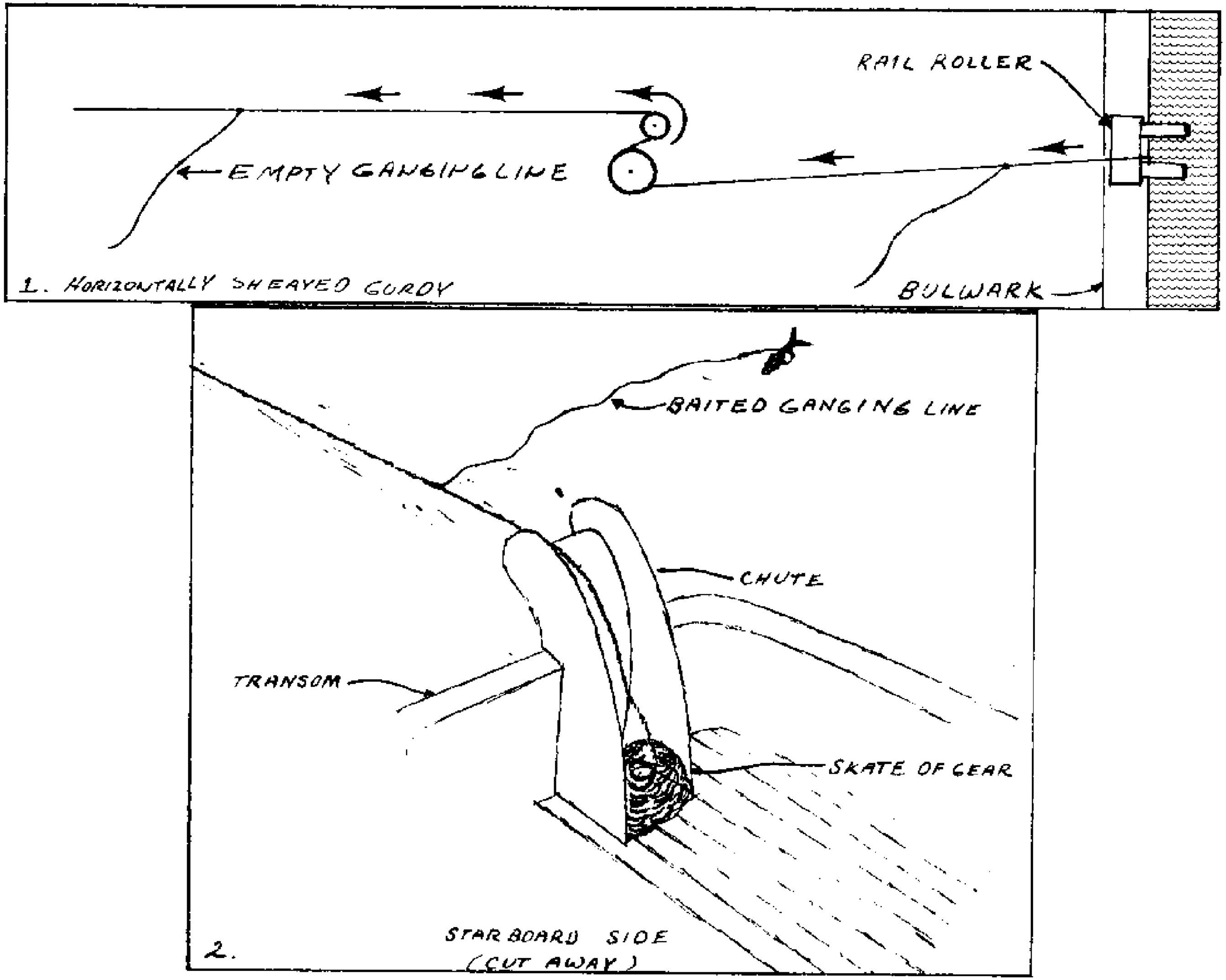


FIGURE 13. SCHEMATIC OF (1) A DECK LAYOUT USING HORIZONTALLY SHEAVED GURDY; (2) SKETCH OF THE CHUTE FOR SETTING SKATE GEAR. After <u>Pacific Fisherman</u> 1939.

mounted on the starboard side prior to pulling the longline. This piece of equipment is usually made of three rollers; two mounted vertically in front of a third horizontally placed roller of a larger diameter. Hauling assistance on the conventional halibut vessel is provided by the horizontally sheaved gurdy which is usually driven either directly from the engine or in some cases through a hydraulic system.

Positive coiling devices have been invented for use in the halibut, black cod, and cod fisheries by Alex Manufacturing in Juneau and MARCO in Washington. Each of these systems has distinct advantages and disadvantages. One major advantage of the automatic coiler by Alex Manufacturing is its ready integration with conventional halibut gear. The major advantage of the MARCO Ti-Liner, alternatively, is the ease with which lines are set, retrieved, and stored through their unique spool system.

However, the important considerations to be made when discussing longling gear development for halibut are the durability of the resource and the size of the industry. Discussions with Saugen (1979) about the possibility of adapting Mustad's autoline system to halibut fishing seems to indicate that Mustad, at least, is not willing at this time to spend any more effort on the development of gear systems for halibut. The reasons are obvious. Because of the recent attention paid to bottomfish development in Alaska, halibut longlining and halibut fishing in general may go the way the halibut fishing went in the North Atlantic; a swift collapse with the advent of less selective fishing gears.

Since halibut are large creatures, the person at the roller has a dangerous job. He must avoid the hooks coming over the roller and onto the gurdy, and must also be good at cleanly gaffing and clubbing large halibut which can do great damage to deck and crew. Research on milky or chalky halibut (Tretsven and Barnett 1970) suggests that the struggling of the fish causes undesirable buildups of lactic acid in the flesh, but care must be exercised in gaffing and clubbing. Money can be lost if many halibut are down graded because of bruises, wounds made by the gaff, or the chalky or milky condition of the meat caused by allowing the fish to struggle.

Onboard Processing

After the haul has been brought aboard, the fish are gutted, gilled, and bled. The body cavity is scraped and washed to rid the "poke" of the kidney and blood residual. The cleaned fish should be cooled to storage temperature as quickly as possible. Poor handling of smaller halibut which affects the quality of those fish can introduce spoilage into the whole hold. Temperature changes in small fish are much more rapid than in large fish, and spoilage can be initiated by a small portion of the catch.

Bait and Ice as Components of the Fishing Operation

The availability of bait is an important part of the longlining operation. It is a major cost factor to the fisherman. Bait and its availability can be a strong drawing card for the processing community and affords them a better chance of drawing a part of the fleet into port. Different types of bait are used, the most important are herring and octopus, but cod, salmon trimmings, sablefish, and turbot are also used. In some cases, small amounts of herring are bought to build up supplies of "gurdy bait" which is the bait-fish taken on the longline gear. Many other groundfish, like eels and cods, are used in varying conditions. Octopus, however, is thought to provide high yields, but is also expensive to use compared with other bait. Nevertheless, octopus may be used in small quantities to improve chances of high yields in low yield areas, or in areas where the bait must be firmly attached to the hooks.

The baiting operation is usually done in conjunction with hook and line repair. As a result, these operations are usually done in the aft section of the vessel under a bait "shack", which is a small enclosure that protects the fishermen from the weather while they are baiting.

Many different chilling and storage techniques are used in the halibut fishery. Refrigerated seawater preserves the flesh in excellent condition, but sometimes produces a fish with a blotched and scaled outside skin. Until the extremely short seasons of the halibut fishery in recent years, it looked as though the freezing process taken on by processors in port might be done by fishermen at sea (Gibbard 1978). However, a well-constructed fish hold with an auxiliary refrigeration system, in addition to crushed ice, is relatively convenient, keeps the product at a temperature that prevents dehydration, and usually delivers a good product to the dock if the boat returns within about two weeks. Icing technology and tending techniques have been well researched and, since the basic method of holding fish has changed little, most of this research is still current.

The availability of ice in large quantities is another positive processor's selling device to fishermen. In some cases, gentlemen's agreements give discounts or free ice to a valuable fisherman. Ice comes in different types, all bearing different thermal qualities that stem mostly from density rather than volume. The best ice is dry and "old" crushed ice. The worst ice is snow, because it dehydrates the fish by wicking moisture away from the carcass. Flake ice is commonly used in the industry. Although ice used in conjunction with other refrigeration prolongs the use of the ice, temperatures that are too low reduce the effectiveness of ice in keeping the fish moist.

On the model halibut vessel, the optimum temperature maintained with refrigeration and ice is in the freezing point depression range--29° to 32°F. At points below 29°F, ice and fish begin to freeze hard and dehydration may result. At temperatures right around 32°F, ice begins to melt, and its ability to absorb heat is the greatest. The melted water is useful in keeping the surface of halibut carcasses clean.

The "poke" or visceral cavity is filled with ice, and the fish are lowered into the fish hold and stacked white side up to prevent unsightly hemorrhage on the white side of the halibut. Only a minimum amount of ice is used in the stacking process outside the body cavity to reduce discoloration of the white side by bacteria, and to minimize the effect of ice indentations on the skin of the fish. Fish with the visceral cavity full of ice are stacked tightly to prevent excessive contact with free oxygen, placed in pens, and covered over the tops and sides with ice. (Tretsven and Barnett 1970).

Problems

However, it is apparent from presentations by food technologists and refrigeration researchers that some halibut vessels are far from model (Gibbard 1978). Either by neglect or through practices that are well-intentioned but in error, some halibut boats may ruin their chances of selling prime fish because of poor handling. Research by the National Marine Fisheries Service (Tretsven and Barnett 1970) has identified several problems that vessels may have that reduce the quality of halibut held on vessels:

1. Insufficient icing of small halibut. Chicken and small medium halibut require more ice than large, well-packed halibut. It is necessary to prevent them from spoiling in order to preserve the quality of the whole catch. The problem with chicken halibut has been largely eliminated by the IPHC size regulations that went into effect in 1973 in Areas 2 and 3 and in 1974 for Area 4.

2. Gaff marks on the body of the fish, bruises, hemorrhage marks on the white side. The remedies for these problems are proper use of gaff and club, and storage of the fish white side up.

3. Yellowing of the white side (greenish tinge) and presence of aerobic bacteria (*Pseudomonas florescens*) caused by exposure to the air and small clumps of ice on the skin of the fish. The remedy is to pack the catch well, use a minimum of ice between the fish, and cover the tops and sides thoroughly with ice to eliminate flow of air around fish.

4. Temperature problems. Install several thermometers in different parts of the fish hold. Pre-chill fish in freezing brine or slush dip just before icing. Process promptly. Make sure fish storage is well insulated from heat generating sources.

5. Ice indentation. Use ice sparingly between fish. Avoid stacking fish too high.

Trends in the Halibut Industry

As exvessel prices climb higher because of limited supply and strong demand it becomes more feasible for fishermen to develop methods that would preserve the quality of their catch to insure the maximum price.

It is necessary in some cases to give some fishermen the incentive to upgrade the quality of their catch. One method of assuring high quality fish is through price incentives. This would mean paying premium prices for good quality fish and a considerably lower price for poorer quality. If quality standards and prices can be agreed upon prior to the season, then all members of the industry can know what to expect during the season.

Price differentials based on the quality of the fish are often discussed and are needed, but are not yet a reality. Starting in the late 1960s, when halibut was scarce, the halibut fishery became a seller's market and has remained so. Shortened seasons enabled most halibut vessels to bring in a better product than before. However, these developments do not mean that good quality fish is now consistently sold to the processors. It merely means that many processors at this time are lenient in grading. Fishermen have been forced by regulations to shorten their fishing trips. Grading, contracting, and quality control in agricultural marketing are all extremely complex issues that sometimes require the help of competent industry analysts. It may, therefore, be helpful for the interested reader to consult agricultural economics literature pertaining to these topics.

An alternative to proving or contracting schemes to improve the quality of halibut (as well as other fish) is better on-board storage. This may include the use of refrigerated seawater, champagne or slush ice, or a combination of refrigeration and icing with super-insulated holds. The use of freezers on board vessels is not likely to gain wide acceptance in the near future, because this reduces the product control that processors need. Some members of the processing sector complain that even in present situations of marketing halibut and other frozen fish, they do not have sufficient product control to maintain quality. However, if a more formalized working arrangement between processors and fishermen could be developed whereby the obvious advantages of freezing at sea could be utilized without eroding the ability of the processor to control the quality of the product, then freezing at sea could become attractive.

Another argument for working relations between processors and fishermen is that there are definite transaction costs to the fishermen and to the processor in having uncertain production in any year. Part of this uncertainty is alleviated by area quotas and closed seasons set by IPHC. But the problem for processors still exists of just how much fish they can count on to be landed to them. In the face of potential capacity problems in the industry with respect to a valuable resource in small supply, the problem becomes one of how to assure the continued business of the independent fishermen and yet have them bring in consistently high-quality fish.

Processing Technology

Current Processing Methods

Although there had been several attempts historically to can, pudding, pickle, smoke and salt halibut, these ventures were set aside for fresh and frozen whole, filleted or steaked product (Appendix VIII). The successful processing of halibut is dependent on adequate freezing and cold storage facilities on site, as well as freezer transport from remote points. Air freight to gourmet markets is becoming more popular. Alaska's main method of transport to distant markets is shipment by refrigerated freighter ship to Seattle, where the product awaits further processing, and then distribution by air or truck. One can infer from Figure 14 that remote production centers in Alaska will have problems both in assuring the availability of capacity for other species and insuring that fish can be aggregated and distributed to Seattle at a profit.

It is seldom that the retail processed form occurs in the same plant that received the catch. Four major product changes occur; these are the initial freezing, glazing, storage, and portioning. At the beginning of the season, the decision may be made to sell some fresh fish to local and distant markets. Depending on the manager's perception of the season's success, as the season progresses he will place his entire emphasis on cold storage.

The halibut is usually drawn (gilled and gutted) at sea. The processor beheads the fish with an automatic guillotine, being careful to avoid damage to the cheeks of the halibut, which are located below and slightly behind the eyeline on the gill cover. After the beheading occurs, the halibut are weighed, graded, and washed. The washing includes the sliming operation, which is carried out with a combination scraper blade-brush.

Halibut grading has changed several times through history; some of the grading methods used in different decades (such as the distinction between western Alaska and local halibut) had some rationale, but other grading criteria appeared inscrutable. Trade journals from the early 1900s, as well as writings by IPHC, are replete with pictures and accounts of the heavy culls rejected because of "worms" or some similar quality determination. One must, therefore, assume that the determination of a No. 1 (first quality) and a No. 2 (second quality), especially prior to 1950, was based not only on where the fish were caught, the weight, and the quality, but also the processor's capacity in relation to the size of the catch. One can also easily see that the grading table was a center for frequent disputes and received careful scrutiny from members of the selling party.

However, since there has been a general scarcity of the resource recently, as well as a strong institutional market developing for halibut fletches and the IPHC ban on taking halibut formerly classed as chicken (or chix), the grading has become increasingly preoccupied with tangible quality criteria (such as smell and texture) and is lenient even on these criteria sometimes in order to maintain good relations with fishermen who in general would bring in an excellent product anyway. It is also likely that split seasons of the type used in the halibut fishery actually contribute to a better product than could be obtained in earlier history. This in itself is probably a major reason for the low proportion of culls in the halibut fishery of today.

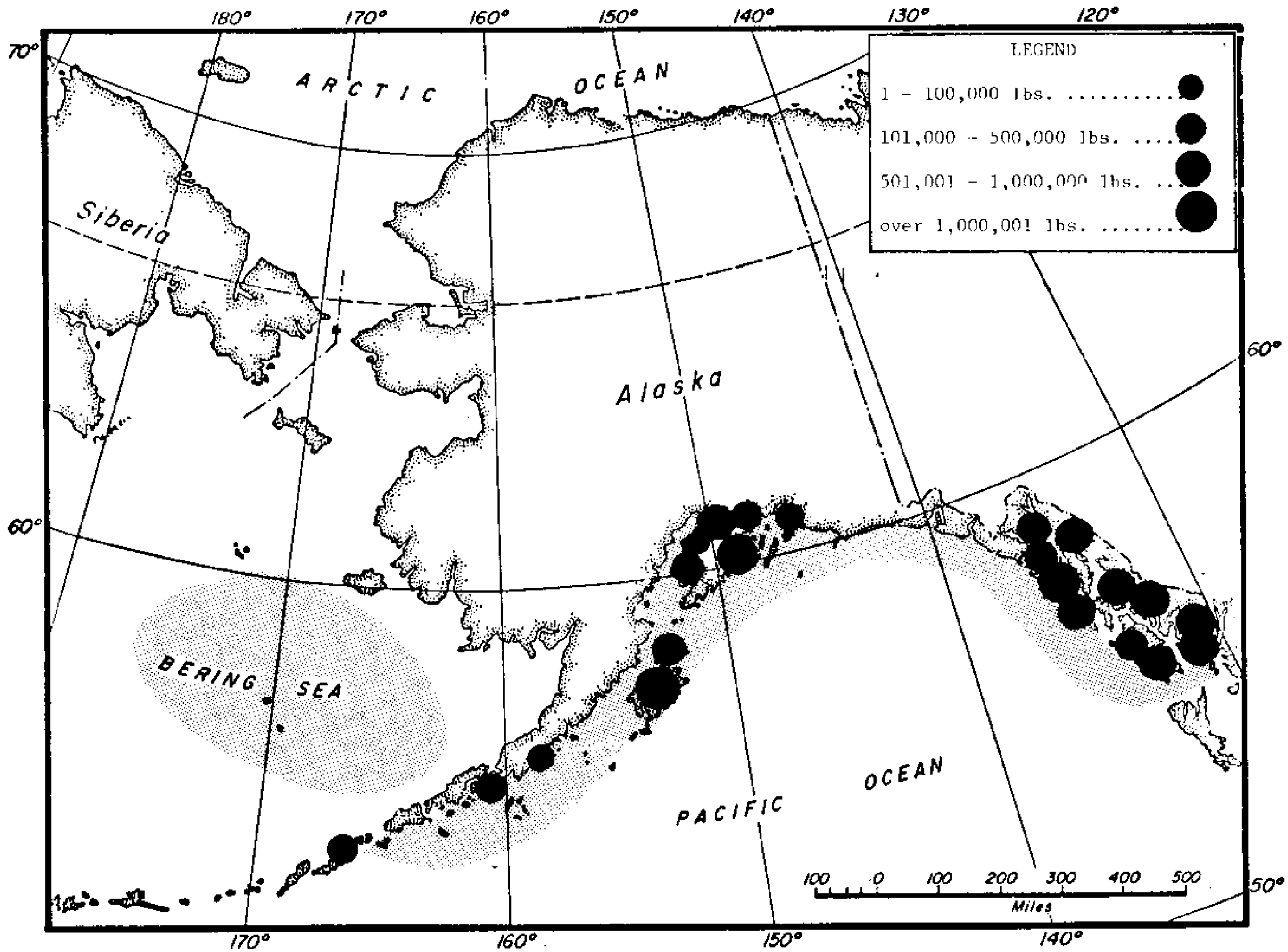


FIGURE 14. GENERAL DISTRIBUTION OF MAJOR ALASKA HALIBUT FISHING GROUNDS (SHADED AREAS) AND DISTRIBUTION OF PROCESSING CENTERS. Data taken from the International Pacific Halibut Commission Technical Report No. 6 and the Alaska Department of Fish and Game.

The share system commonly used on fishing boats may contribute indirectly to lower quality of the fish. Fishermen will sometimes work shorthanded to increase the individual share. As a result, fish may not get proper attention. However, if a large amount of fish fall into grade 2 or are rejected, each crew member's share will be significantly diminished anyway. The optimal amount of labor was not used relative to other costs. Therefore, grading by the processor is the most reliable means of assuring a quality product for processing.

Types of freezers and freezer set-ups are almost as numerous as processing firms. Freezer systems depend on the expected quantity and pace of processing halibut and other major species. Freezing equipment is sufficiently non-specialized to be quite versatile. Freezers are run on a variety of coolant gases. These may include different types of coolants such as Freon, nitrogen, or ammonia which can be used in blast freezers, sharp freezers, or plate or brine freezing apparatus (Browning 1974, p. 268). The important step requires freezing the whole carcass as quickly as possible (usually over 12 hours) and maintaining the core of the fish at temperatures well below $0^{\circ}F$, usually at temperatures to $-40^{\circ}F$.

The next step in processing is glazing, a labor intensive process that must be done to exact specifications. Water held at just above freezing is either sprayed on the hard frozen carcass, or the carcass is dipped into the water which coats the whole fish with ice. This may be repeated periodically at the place of storage to insure that the fish is not damaged by freezer burn (dehydration of the flesh) or oxidation. The dressed, frozen, and glazed halibut then enters cold storage, usually in Seattle, where it is held until it is distributed to other major cold storage facilities throughout the U.S. The shelf life of frozen fish varies with the fish type and temperature. Browning (1974) states that, in cold storage at $15^{\circ}F$, the maximum length of time the product can be held is 30 days. At $-20^{\circ}F$, the maximum length is eight months before the fish begins to lose quality. Any wide fluctuation in temperature of cold-stored fish tends to diminish the overall quality of the final product.

Depending on market conditions, the storage may last up to a year when the fishing season starts again. However, processors in Alaska have a tendency to free storage space as quickly as possible by shipping the product to Seattle, to make room for salmon or crab, depending on the time of year (Pugh 1978). The whole fish is taken out of storage, placed on totes--containers of 1,800 or 750 pounds--and shipped to Seattle or distant cities, where steaking and filleting take place (Reinhardt 1978). Another current method uses large refrigerator storage vans that are loaded directly onto the freighter (Jensen 1978).

Steaking of halibut is usually done on band saws while the halibut is frozen. However, fletching is usually done at the initial processing plant in Alaska. In both cases, the fish is checked around the nape and belly cavity for parasites, and if there are none, these areas of the fish are also used. The fletch is a large skinless, boneless fillet or side of a large halibut. This fletch is usually cut into quarters, frozen, and glazed. The steaks, after having been brined and glazed, may be placed in shipping boxes of five, ten, and 15 pounds, and distributed to other parts of the country.

Because these smaller sized and more easily handled products have a reduced shelf life and higher transportation costs, these activities are usually done for the customer on demand so that quality of the meat can be maintained. The actual steaking is usually done as close to the final distribution of the product as possible (Reinhardt 1978). Many strenuous objections have been raised in regard to the practice of partially thawing the dressed halibut for the purpose of steaking and making fletches. Sources attribute poor marketing performance of halibut in some cities to the partial thawing of halibut for these levels of processing.

Possibilities for Innovation

One major halibut producer is considering the possibility of preparing frozen portions using Kry-o-vac packages which would eliminate the need for glazing. The product would be marketed directly to the final consumer in an attractive package that would assure some product control at the retail level.

In the interest of maintaining quality control, there seems to be a trend toward re-examination of the practice of dividing different stages of processing along the route of distribution, to maintaining quality control. However, successful portioning, freezing, packaging, and storage is restricted by: freezer life of portioned foods, transportation costs of bulk versus portioned halibut, time and storage space constraints on some buyers of halibut, and barriers to entry caused by the need for specialized processing equipment at the processing level. A simplified diagram of the processing and distribution activities is shown in Figure 15.

Capacity and Capacity Utilization

Processing capacity for halibut is determined by the amount of freezer space available, although maximum capacity could be restricted by bottlenecks in production or harvesting. The freezer is a relatively non-specific type of equipment that can, in lean years for halibut, serve other purposes. The catch of halibut has decreased drastically from record catches of over 74.8 million pounds in 1962 (dressed weight, United States and Canada) to a proposed limit of 20.0 million pounds (dressed weight, United States and Canada, for Areas 2 and 3) in 1978. The premium price of halibut, due to a great market strength, makes it very attractive, especially to processors who specialize in cold storage. In the short run, the impact of a poor year for halibut may cause an overcapacity problem but, with the long-term downward trend in the halibut fishery, sufficient signals are available to spur processors into solving this overcapacity problem by branching into other fisheries.

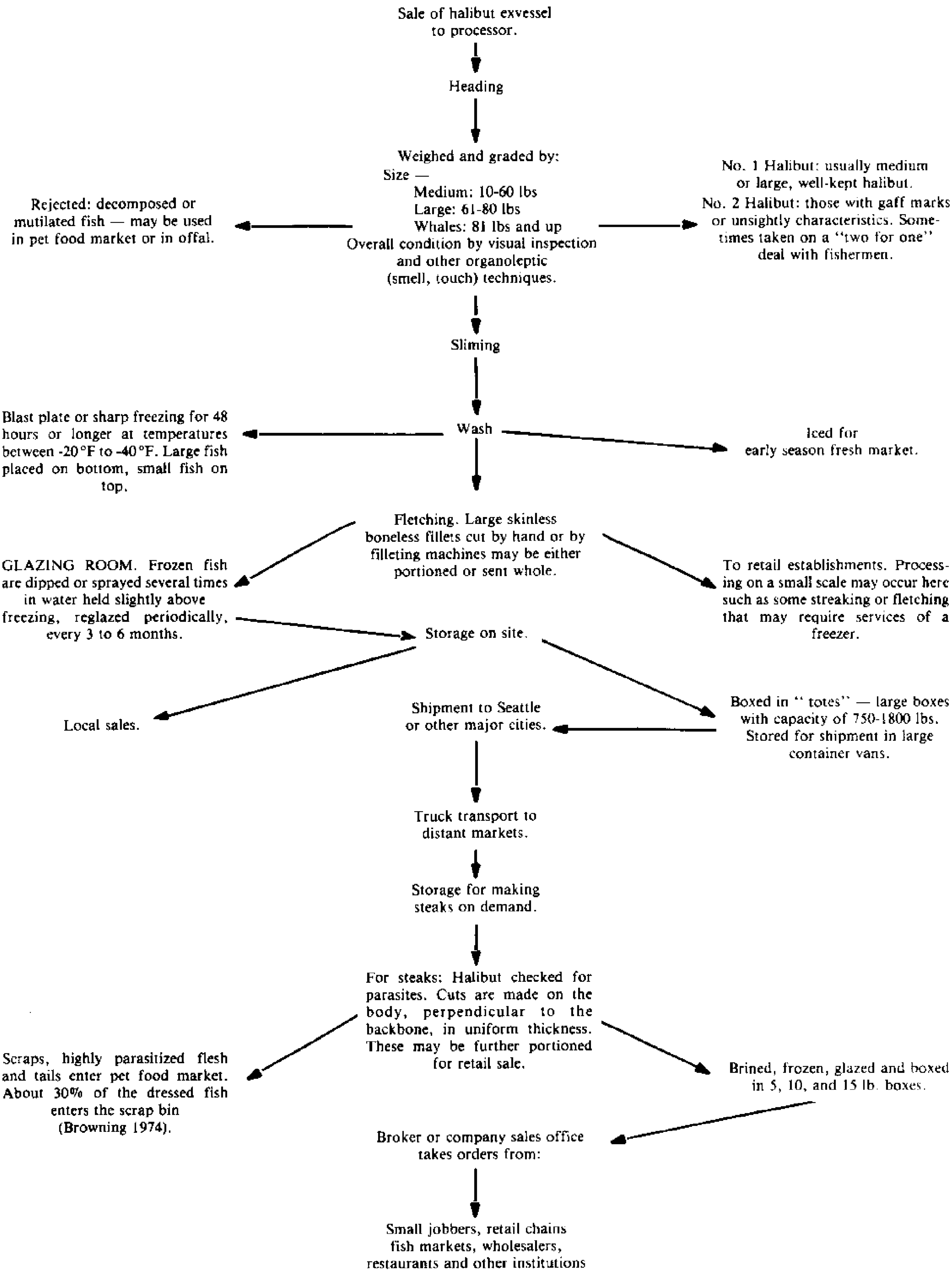


FIGURE 15. PROCESSING AND DISTRIBUTION OF HALIBUT

CHAPTER VI

MARKETS, PRICING, DEMAND AND PROJECTIONS FOR HALIBUT

Introduction

In the Pacific Northwest, price data and marketing information for public use are confined largely to government sources. The absence of comprehensive price data at exvessel, wholesale, and retail sales is a limiting factor to any market analysis. There are indeed a few places like Seattle, Vancouver, Prince Rupert, and Kodiak that either presently have, or have made attempts at forming an exchange. However, in general, there is a lack of common marketing places where many buyers and sellers may meet and bargain on price, and have these prices simultaneously recorded in a relatively costless manner.

Processors have not been required to divulge exvessel price information to state or federal agencies. As a result, reporting that information is given low priority by buyers. This is not surprising because in the short run the industry sees little benefit in complying.

Seattle, the major exvessel trading center in the past, generally employed auction sales. Seattle has had a diminishing role in exvessel sales but has shifted emphasis to secondary processing and distribution of the product as it arrives from Alaska. Direct sales to processors in Alaska have increased, and this has had a tendency to disperse points of sale rather than aggregate them. This, in combination with the poor halibut catches of the last eight years and the small price differential between Seattle and Alaska, has reduced the number of sellers and subsequently the number of regular buyers in the Seattle auction. This reduction in the number of participants in the Seattle market has greatly reduced the volume of halibut received (Alverson 1978).

The fishing vessel owner or master of the boat has several avenues open to him in marketing his catch. In the larger ports, mimimum price is negotiated before the season. More often, vessel owners may obtain nonprice benefits. These benefits apparently work to the advantage of both parties but tend to cloud the issue of exvessel price. For instance, a captain and crew may be given the opportunity to clean up or do laundry and grocery shopping, using a car supplied by the processor, or might be put up for the night or flown home between trips at the expense of the processor (Myhre 1978; Alverson 1978; Fergeson 1978). All of these services necessarily raise the cost of the raw product to the processor and reduces the cost of supplying the product, and is not reflected in the reported price. The relationship between seller and buyer of halibut suggests a seller's market, not so much because of the difficulty of finding another use for the processing space, but because of the unusually strong consumer demand for the halibut supply. Consumer demand is, of course, directly reflected in the processor's demand for halibut.

Since it is a seller's market for halibut and since most of the halibut caught in the U.S. comes from Alaska, Alaska processors have a much different arrangement with the processing firms from Seattle than they had 50 years ago. Instead of being direct competitors, most Seattle processors have agreements with Alaska buyers whereby a share of the fish bought are to go to Seattle processors with an agreed handling fee added to the cost of the fish. Since boats have tended to become smaller and transportation over long distances is a major cost factor (because of short length of seasons and high price of fuel), processors in Alaska benefit from a fairly localized fleet. Also, the fisherman, in the short run, has very little control over how long the product can be held, and theoretically could be at a disadvantage at the grading table or in price negotiations after he reaches the port. But in today's negotiations, the tendency is for processors to insure a steady flow of product by being generous in things such as grading, benefits, and bonuses. For the fisherman, the problem of overcommitting the catch by not knowing price prior to reaching port can now be avoided by single-side-band radio communication while the fisherman is still at sea (Myhre 1978).

Types of Market Systems at the Exvessel Level

The Exchange

The exchange or auction was the accepted marketing channel in major ports such as Seattle. The vessels, on returning to port, would head for the exchange, hail their fares (give an estimated weight), and give an approximate location of where the fish were caught. The hail was bid upon and sold to the highest bidder. From that point on, the buyer, under crew supervision, performed the grading and weighing of the fish. Today, without the auction system, a member of the crew will still look on as grading and weighing takes place. There may be considerable bargaining at the grading table (Alverson 1978). Auctions, while still in existence, are not as wide-spread as they used to be. Presently, the Seattle Fish Exchange, operated by the Seattle Fishing Vessel Owners Association, handles a negligible amount of halibut compared to its importance in the 1960s. The number of buyers in recent years has decreased from 14 to four. Fisherman now prefer direct negotiations, and many times find it more profitable to sell locally without making the run to Seattle. This trend, however, may change if Seattle prices relative to Alaskan prices climb high enough in 1978 to offset the cost of transportation to Seattle (Alverson 1978).

Direct Sales to a Processor

In areas where only one or two processors are available, the fisherman may have had some prior contact or good business relationship with a processor and will, as a matter of custom, consider selling to the processor first. Or he may try to contact processors by radio and discuss price before making for port. This method works well in dispersed markets where a number of buyers are not available to vie for the product. The tendency is for informality. Agreements are usually informal verbal agreements made in good faith by both parties.

The Marketing Cooperative

The best example of a viable cooperative development in the halibut fishery is the relationship between the Fishermen's Cooperative Association in Prince Rupert, British Columbia, and the Halibut Producers Co-op in Bellingham, Washington. Prince Rupert, the older association, holds controlling interest in Fishermen's Federation, Inc. which sells for both associations in the United States. "The original association was one of the founding members of the Fishermen's Cooperative Federation (FCF), the central marketing organization. Today, the FCF is a subsidiary of the association but carries on the function of marketing fish for the assocation in Canada and Europe. The association has held for over 20 years the controlling shares in an American sales company known as Fisherman's Federation, Incorporated (FFI). The remaining shares are held by an American fisherman's cooperative with headquarters in Seattle, Washington[1]. The FFI is administered by the boards of directors of the two parent associations and is managed by the Prince Rupert Association. It sells fish in the United States for both Cooperatives." (FAO, 1971, p. 49).

Cooperative involvement by otherwise independent fishermen tends to be long-term. There are incentives for fishermen to remain loyal to the cooperative. The cooperative is obligated to take fish from the fishermen and, likewise, the member fishermen are obligated to deliver their catch, except in cases where the fisherman exempts himself from the terms of the contract for the following year or the obligation is waived by the board of directors. Penalties for breach of contract, although provided for in the agreement, are not always strictly enforced. The fisherman may, however, risk a loss in equity if he leaves the cooperative and continues fishing.

"When a member delivers his fish to the association, he receives an advance payment, the rate of which is approximately 70 percent of the value of the fish as estimated at the time of delivery. At the end of each fiscal year (31 March) a careful accounting is made of the sales of all fish during the preceding 12 months plus a valuation of inventory of all unsold fish at that date. (Processing, holding, and sales costs are separated by species to facilitate equitable payments to the different fishermen.) From this, of course, the inventory of fish on hand at the beginning of the same fiscal year has to be deducted and from this, in turn, are deducted expenses incurred in handling the fish, both in processing and sales. Overhead and administrative expenses are also deducted--usually as a percentage of the sales made to the processor. The resulting final settlement is then worked out and actually paid to the members on 1 December." (FAO, 1971, p. 53).

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[1]Now Bellingham, Washington.

Prince Rupert seems to consistently buy at higher per unit prices than in Ketchikan. The railroad terminal in Prince Rupert, the differences between the cooperative market structure mentioned above, and other conventional buying and selling methods are probable causes of the price differential. However, this apparent price differential does not account for the services and bonuses that Ketchikan processors may have made to fishermen that are not reflected in the price. The Prince Rupert Cooperative, on the other hand, does not have to resort to bargaining in areas other than price. This may have the effect of making halibut prices quoted in Prince Rupert seem high when, actually, they may represent an equilibrium, undistorted by nonprice compensation, between derived demands for the product and willingness to supply by the fishermen.

Grading

Grading of halibut has undergone several major changes, each time in response to a major change in the industry. Dressed chicken halibut, weighing from five to ten pounds inclusive, are no longer legal catch. The new size limit was imposed by the IPHC in 1973 for Areas 2 and 3, and in 1974 for Area 4.

The optimum grade historically was a medium in number-one condition. A halibut of this class prior to 1931 had good odor, looked good, and weighed between ten and 80 pounds, dressed. In 1931, the medium class was changed to cover halibut weighing between ten and 60 pounds. Most fishermen did not like this. However, with the advent of new markets for the large fillets called fletches, a better price at the exvessel level became more apparent for the larger fish, and the size of the halibut in relation to exvessel price has subsequently become a less important factor. At one time, there was even a grade by geographic area: the western-caught halibut versus the local halibut. In general, however, the area that stayed open the longest in the fall, regardless of quality considerations, generally yielded the strongest price grade because processors would want to attract as much of the raw product as possible as the exvessel market started to dry up for the winter.

Presently, the grades fall into medium (ten to 59 pounds inclusive), large (60 to 79 pounds inclusive), and whales (80 pounds and up). Within each of these grades, the fish may be classed as number 1 or 2, depending on its overall condition resulting from handling and the extent of blemishes that are uncontrollable by the fishermen, such as sand flea wounds and sea lion bites (Appendix IX). Fish that are graded number 2 may have parts of it salvaged, depending on the extent of damage on the fish carcass.

Pricing

Exvessel

Tables 44, 45, and 46 show exvessel prices for medium number 1 halibut in Seattle; Ketchikan; and Prince Rupert, British Columbia, respectively. Over comparable time periods within the data sets, it can be seen that

TABLE 44

SEATTLE AVERAGE EXVESSEL PRICE PER POUND OF FRESH
OR FROZEN HALIBUT (DRESSED WEIGHT)
(In Cents)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.	Halibut Index	Avg. Value CPI Fish	Avg. Value CPI MP&F
1960	-	-	-	18.7	17.8	18.1	18.9	19.4	20.4	22.4	25.0	-	20.1	78.5	23.7	22.6
1961	-	-	-	22.9	22.0	23.2	23.6	26.5	27.4	29.9	30.0	-	25.7	100.4	29.6	28.8
1962	-	-	-	30.5	30.7	33.0	34.5	34.7	33.7	33.2	31.8	-	32.8	128.1	36.2	35.9
1963	-	-	-	24.5	23.3	24.0	23.3	21.6	23.9	22.2	25.7	-	23.6	92.2	26.1	26.2
1964	-	-	21.7	23.0	23.5	25.4	26.9	27.2	29.0	28.9	34.9	-	26.7	104.3	30.3	30.1
1965	-	-	-	30.6	29.9	33.6	37.0	37.0	36.4	37.2	38.6	-	35.0	136.7	38.6	37.0
1966	-	-	-	-	34.1	36.3	37.8	36.8	33.1	-	-	-	35.6	139.1	36.8	34.7
1967	-	-	-	-	25.3	25.4	25.6	24.4	25.3	26.6	26.9	-	25.6	100.0	25.6	25.6
1968	-	-	-	26.4	23.7	25.0	24.9	24.9	27.1	31.5	33.5	-	27.1	105.9	26.1	26.5
1969	-	-	-	35.4	36.9	39.2	43.4	45.3	42.4	43.5	43.3	-	41.2	160.9	38.4	37.2
1970	-	-	-	43.4	40.1	43.0	44.0	39.8	34.9	32.5	35.6	-	39.2	153.1	33.2	33.7
1971	-	-	-	34.9	33.1	35.8	36.2	36.7	39.4	41.6	-	-	36.8	143.8	28.3	31.5
1972	-	-	-	60.3	58.3	65.7	70.5	57.3	73.1	-	-	-	64.2	250.8	45.2	50.2

TABLE 44 (Continued)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.	Halibut Index	Avg. Value CPI Fish	Avg. Value CPI MP&F
1973	-	-	-	-	-	79.0	84.5	86.6	-	-	-	-	83.4	325.8	51.2	52.0
1974	-	-	-	-	75.0	79.0	79.6	80.5	-	-	-	-	78.5	306.6	41.8	47.9
1975	-	-	-	-	90.0	91.3	94.8	102.7	108.5	-	-	-	97.5	380.9	48.0	54.8
1976	-	-	-	-	NA	NA	NA	NA	NA	NA	-	-	-	-	-	-
1977	-	-	-	-	NA	NA	NA	NA	NA	NA	-	-	-	-	-	-

Source: Bureau of Commercial Fisheries Food Fish Situation and Outlook (1960-1970); NMFS Food Fish Market Review and Outlook (1971-1977); and Bureau of Labor Statistics Handbook of Labor Statistics (1976 and 1971). Base year is 1967. All prices are for No. 1 medium halibut. From 1959 on, Halibut graded No. 2 sells for 4¢ per pound less than No. 1 in each grade.

TABLE 45

EXVESSEL WEIGHTED AVERAGE PRICE PER POUND
FOR DRESSED MEDIUM HALIBUT AT KETCHIKAN
(In Cents)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave.	Halibut Index	Average CPI Fish	Average CPI MP&F
1965	-	-	-	-	26.3	30.6	34.3	34.5	-	-	-	-	31.4	146.7	34.6	33.2
1966	-	-	-	-	29.4	32.8	34.5	35.0	-	-	-	-	32.9	153.7	34.0	32.1
1967	-	-	-	-	20.4	22.2	21.6	20.7	-	-	-	-	21.4	100.0	21.4	21.4
1968	-	-	-	-	20.0	19.8	20.5	21.0	-	-	-	-	20.3	94.9	20.0	19.9
1969	-	-	-	-	29.3	34.5	37.5	46.0	-	-	-	-	37.2	173.8	34.7	33.6
1970	-	-	-	-	35.5	39.1	39.2	37.3	-	-	-	-	37.8	176.6	32.0	32.5
1971	-	-	-	-	31.0	31.0	31.3	-	-	-	-	-	31.1	145.3	23.9	26.6
1972	-	-	-	-	-	-	-	70.0	-	-	-	-	70.0	327.1	49.3	54.7
1973	-	-	-	-	50.0	-	-	-	-	-	-	-	50.0	233.6	30.7	31.2
1974	No further reports.															

Source: Bureau of Commercial Fisheries Food Fish Situation and Outlook (1965-1970); NMFS Food Fish Market Review and Outlook (1971-1974); and Bureau of Labor Statistics Handbook of Labor Statistics (1976 and 1971). Base year is 1967. All prices are for No. 1 medium halibut.

TABLE 46

EXVESSEL WEIGHTED AVERAGE PRICE PER POUND
FOR DRESSED MEDIUM HALIBUT AT PRINCE RUPERT, B.C.
(In Cents)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ave.	Halibut Index	Average CPI Fish	Average CPI MP&F
1965	-	-	-	29.9	29.1	33.3	34.8	38.2	37.8	-	-	-	33.9	137.3	37.3	35.9
1966	-	-	-	35.6	33.3	35.2	36.6	36.8	36.1	-	-	-	35.6	144.1	36.8	34.7
1967	-	-	-	-	24.7	24.4	Direct Sale	24.4	24.6	25.6	-	-	24.7	100.0	24.7	24.7
1968	-	-	-	22.6	24.4	22.7	22.9	-	-	-	-	-	23.2	93.9	22.8	22.7
1969	-	-	-	-	36.7	40.9	43.3	45.3	44.1	43.7	-	-	42.3	171.3	39.5	38.2
1970	-	-	-	-	39.4	42.6	42.5	38.9	35.6	31.7	-	-	38.5	155.9	32.6	33.1
1971	-	-	-	-	33.6	32.7	34.0	37.4	37.8	-	-	-	35.1	142.1	27.0	30.0
1972	-	-	-	-	59.8	66.6	72.5	76.3	78.5	-	-	-	70.7	286.2	49.8	55.2
1973	-	-	-	-	-	73.4	78.2	81.4	86.0	-	-	-	79.8	323.1	49.0	49.8
1974	-	-	-	-	-	67.8	71.0	77.3	78.6	-	-	-	73.7	298.4	39.3	45.0
1975	-	-	-	-	75.0	81.0	93.0	NA	111.7	-	-	-	83.8	339.3	41.2	47.1
1976	-	-	-	-	134.0	134.9	127.1	125.2	123.7	-	-	-	130.4	527.9	57.4	72.7
1977	-	-	-	-	NA	123.5	136.2	137.2	139.5	-	-	-	131.4	532.0	52.2	73.7

Source: Food Fish Market Review and Outlook, December 1977; Monthly Summaries of Market News Service.

Ketchikan exvessel prices are lower than either Prince Rupert (a railroad terminal and cooperative influenced town) or Seattle (where fish exchanges and auctions are still utilized). Table 47 describes exvessel prices in Kodiak, Alaska, from 1971 to 1978 for size grades of number 1 quality, and generally shows a further price differential that is below other ports and which reflects transportation costs. The exvessel prices described here do not include extras or benefits that processors extend to fishermen. Kodiak exvessel prices also suggest that the larger halibut are now the favored grades. Within the season, however, exvessel pricing becomes more complex and is largely determined by whether the demand for halibut is for inventory or for the fresh market. Wide fluctuations in exvessel price over the season are usually the result of fluctuations in the demand for fresh fish because the fresh product is not stored over long periods of time. An unresponsive price over the season is a characteristic of the demand for a storable commodity (Crutchfield and Zellner 1963). Since there has been a definite increase in the relative importance of Alaska as a supply source of frozen fish, the exvessel pricing system would tend to reflect a demand for inventory. However, if Alaska processors become involved in air freight shipments in the future, the pricing system may begin to reflect a demand for the fresh market. The seasonal pattern of pricing in the halibut fishery is a function of beginning-of-year carry-over, prices of competing food commodities, storage costs, and the season length and the arrangement of the openings (Crutchfield and Zellner 1963). Season length, which is mainly controlled by the IPHC, plays a particularly important role in pricing patterns, with shorter seasons causing faster price increases than long seasons. This phenomenon apparently results from the desire of processors to insure an adequate inventory for themselves over the year.

Wholesale

The wholesale price reflects the transportation costs of the wholesaler and any additional processing costs that the product might undergo enroute to the retail shelf. This would include storage and brokerage fees. For comparison with exvessel prices, spot wholesale prices for New York and Boston are shown in Tables 48 and 49, and yearly averages of price are set in real terms with the Wholesale Price Index (WPI) for meat, poultry, and fish. The real price of halibut, with respect to other meat products, has been increasing rapidly since 1970 and reflects what is already apparent in the retail market and in the catch. The resource, while in a serious state of decline, seems to have an extremely strong demand. This phenomenon is discussed in a subsequent section.

Retail Prices and Marketing

Most of the halibut sold to the public is in the form of transverse cut steaks from the carcass or other portions taken from the fletch. Because there is a general tendency for fish to be consumed outside the home in restaurants (Gillespie and Schwartz 1977), the institutional and restaurant market is an important aspect of halibut sales. A limited market is available in the fresh trade, where fresh, iced halibut are flown to distant markets. The final form may either be fresh, thawed, or frozen.

TABLE 47

KODIAK EXVESSEL PRICES BY SIZE, GRADE, MONTH, AND YEAR, 1971 TO 1977, WITH AVERAGE EXVESSEL PRICES BY GRADE[1]
(In Cents)

Year	Grade	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
1971	Chix	-	-	-	*	16	18	18	18	18	-	-	-	17.8
	Med.	-	-	-	*	29	29	29.9	31.9	32.5	-	-	-	30.5
	Large	-	-	-	*	27	27	27.9	31.4	33.0	-	-	-	29.3
1972	Chix	-	-	-	*	21.5	21.5	25	25	25	-	-	-	23.6
	Med.	-	-	-	*	47.5	57	62	67	71	-	-	-	60.9
	Large	-	-	-	*	47	57	62	67	71	-	-	-	60.8
1973	Med.	-	-	-	56	62.5	65	72.5	75.5	81.5	83	-	-	70.9
	Large	-	-	-	60	60	70	72.5	75.5	81.5	83	-	-	71.8
1974	Med.	-	-	-	Direct	Direct	59.5	68	68	70	-	-	-	66.4
	Large	-	-	-	Direct	Direct	62.0	73.5	72.5	75.5	-	-	-	70.9
1975	Med.	-	-	-	67.5	68	74.8	87	94	102	105	-	-	85.5
	Large	-	-	-	69.3	74	81.25	87	105	105	115	-	-	90.9
1976	Med.	-	-	-	129	82.5	109	115	123	125	-	-	-	113.9
	Large	-	-	-	129	82.5	118	122	127	133	-	-	-	118.6
1977	Med.	-	-	-	106	112	120	119	118	129	-	-	-	117.3
	Large	-	-	-	110	120	121	122	118	129	-	-	-	120.0

Source: Fishery Market News, NMFS.

[1] Prices by month are defined as the midpoint between the highest and lowest prices quoted over the month. In April of 1971 and 1972, Fishery Market News Reports did not record prices in Kodiak, although landings were recorded. Prices that may occur in months that are closed to halibut fishing are a result of lag times between catching and landing. In 1973, the landing of chicken halibut (5 to 10 pounds) was regulated out of the fishery by a new size ruling by IPHC.

TABLE 48

NEW YORK WHOLESALE PRICE PER POUND OF DRESSED FROZEN PACIFIC HALIBUT BY MONTH AND YEAR WITH CORRESPONDING REAL PRICES FOR THE YEARLY AVERAGE PRICE
(In Cents)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year Average	Halibut Index	WPI MP&F	Avg. Price WPI MP&F
1958	31.2	31.5	32.0	33.8	34.5	40.0	40.0	37.0	36.6	34.3	34.0	33.7	34.9	84.3	102.8	34.0
1959	33.5	33.2	33.3	33.0	34.6	34.0	33.5	34.8	32.7	31.8	31.0	31.2	33.1	80.0	94.5	35.0
1960	30.3	29.2	29.2	30.0	30.2	33.5	34.3	35.5	30.8	30.5	29.8	30.0	31.1	75.1	93.1	33.4
1961	30.0	32.0	32.7	33.3	34.8	37.0	35.0	38.0	39.0	34.7	35.0	35.5	34.8	84.1	90.9	38.3
1962	37.3	39.7	39.5	45.0	41.3	44.0	45.0	47.0	42.8	43.8	43.8	43.0	42.7	103.1	94.4	45.2
1963	43.3	42.5	41.3	40.0	35.8	36.0	36.0	38.5	43.5	43.9	32.8	32.5	38.8	93.7	88.9	43.6
1964	32.5	30.5	30.2	28.0	34.3	36.2	40.0	41.5	55.0	55.5	38.0	40.0	38.5	93.0	86.5	44.5
1965	40.0	39.7	39.7	40.5	40.5	43.8	50.0	50.5	51.0	48.0	47.5	47.7	44.9	108.5	96.2	46.7
1966	47.7	47.0	47.5	47.5	47.5	47.3	48.8	48.0	48.0	47.0	48.0	48.0	47.8	115.5	105.0	45.5
1967	48.0	47.0	44.0	41.0	37.5	37.5	36.0	42.0	44.5	40.8	39.0	39.0	41.4	100.0	100.0	41.4
1968	39.0	34.5	34.5	34.5	34.3	37.2	39.4	41.6	40.6	45.2	38.5	39.0	38.2	92.3	103.1	37.0
1969	41.3	41.3	43.0	47.0	47.0	58.0	62.0	62.0	66.0	60.0	63.0	58.0	54.1	130.7	113.8	47.5
1970	57.5	57.5	57.5	57.5	57.5	57.5	57.5	57.0	57.3	56.7	55.3	54.9	56.9	137.4	115.8	49.1
1971	54.2	54.2	55.0	53.0	53.0	53.0	53.1	53.1	53.1	53.5	55.0	58.5	54.1	130.7	116.0	46.6
1972	62.0	62.1	67.6	72.0	76.8	77.0	85.0	90.1	92.2	95.0	95.0	95.0	80.8	195.2	130.0	62.2
1973	91.8	91.7	90.4	88.0	97.1	99.6	99.6	105.0	105.0	105.0	102.5	102.5	98.0	236.7	167.5	58.5
1974	102.5	102.5	103.0	105.0	99.8	95.8	98.3	98.3	105.0	105.0	105.0	105.0	102.1	246.6	163.5	62.5
1975	105.7	107.1	108.3	115.0	115.0	120.0	120.0	127.0	145.5	149.0	150.0	150.0	126.0	304.4	191.0	66.0
1976	150.0	150.0	150.0	150.0	150.0	165.0	165.0	170.0	173.0	173.0	170.0	170.0	161.4	389.9	181.6	88.9
1977	170.0	170.0	170.0	170.0	170.6	172.9	173.5	175.0	175.0	180.0	180.0	180.0	173.9	420.1	182.0	95.6
1978	180.0	180.0	182.0	186.0									182.0	439.6	193.6	94.0

Source: Fishery Market News Report, National Marine Fisheries Service, New York Market Statistics, as reported in Food Fish Market Review and Outlook, December 1977. Wholesale price indices obtained through Bureau of Labor Statistics Handbook of Labor Statistics, 1971 and 1976, and monthly updates for 1977 and 1978.

TABLE 49

AVERAGE WHOLESALE SPOT PRICE OF DRESSED, FROZEN HALIBUT AT BOSTON
(In Cents)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.	WPI MP&F	Avg. Price WPI MP&F
1972	65.4	72.0	76.0	72.0	70.4	82.5	84.3	90.4	95.0	95.0	95.0	93.8	82.8	130.0	64.7
1973	89.0	89.5	90.0	85.9	86.2	93.0	93.1	97.7	108.3	105.3	105.0	104.2	95.6	167.5	57.1
1974	101.7	102.6	100.6	97.1	94.8	95.8	96.2	100.2	103.7	104.2	104.2	104.5	100.5	163.5	61.5
1975	102.6	104.7	111.7	115.9	115.8	120.0	125.0	133.8	143.4	147.7	153.0	154.0	127.3	191.0	66.7
1976	156.0	158.1	160.5	158.9	161.8	169.8	173.9	170.2	170.3	171.1	167.0	168.6	165.5	181.6	91.1
1977	169.9	169.8	169.9	172.3	173.1	176.4	182.0	182.0	182.0	178.9	178.9	181.6	176.4	182.0	96.9
1978	181.3	182.0	187.5										183.6	193.6	94.8

Source: Wednesday Boston Market News, collected by Economic Research Laboratory, U. S. Department of Commerce.

The U.S. imports a substantial amount of halibut from other countries, principally from Canada (Table 50) and is the major world buyer of halibut. However, since the major producing countries are either directly or indirectly affected by the IPHC management plans, the decreases in U.S. imports do not arise from a reduced consumer interest in the product, but a decrease in its supply. The retail price average for 1973 and the three-month price average for 1978 show a 15 percent increase in the real price of halibut (Table 51). In terms of unadjusted price, this amounts to an 89 percent increase in other meat commodities, and even fish in general. This evidence suggests again that the retail market for halibut is unusually strong.

The foregoing paragraphs do not imply that the retail marketing sector for seafood is not without fault, rather that the demand relative to the available supply is strong. In fact, some authors have come to the conclusion that sales in seafood occur in spite of, rather than resulting from, conventional retailing methods. Gillespie and Loomis (1971) described the problem of consumer acceptance of fish in general in terms that point toward the archaic methods of seafood retailing:

> "It is a fact that annual per capita consumption of seafood has remained at about eleven pounds, while annual per capita consumption of other meat products is around 170 pounds. Perhaps one reason for this wide disparity is the archaic and often poor merchandising practices that have existed for at least the last 20 years. While other forms of merchandising meat products have shown great change, merchandising of seafood products, for the most part, has shown few improvements and little innovation."

Some members of the industry do not share Gillespie's and Loomis's concern about "archaic" methods of fish marketing and merchandising. However, the merchandising techniques for fish that are currently used in most retail markets were developed for more stable muscle structures found in red meat, and are unsuitable for marketing fish today. For instance, thawing a quantity of fish and calling it fresh requires that the product be eaten almost immediately. But often as not, this product will be refrozen for a period of time at the consumers home. There have been few attempts to correct most fish marketing problems, partly because retailers have the illusion that they will never make money on fish anyway, because they have tried using conventional marketing techniques and failed. This problem is compounded when the names of processing companies appear on the label of a product damaged by conventional merchandising. Thus for halibut, as well as other fish, the threat of a company getting a bad name "second hand" through the marketing chain and subsequently losing a potential market is critical. It seems wise then to look at some suggestions that researchers have made with regard to retail merchandising not only for halibut but for fish in general.

Studies in Texas by Gillespie and Loomis (1971) on fresh fish markets suggest that present marketing techniques in chain stores do not take advantage of the full potential that seafood has of turning a profit.

TABLE 50

U.S. HALIBUT IMPORTS BY YEAR FROM 1962 TO 1977[1]

Year	Fillets			Whole or Beheaded				
	Product	Dressed[2]	Value	Product	Value	Dressed Weight Total	Product Weight Total	Value Total
1977	1,600,935	4,008,421	2,857,728	5,907,236	8,259,784	9,915,657	7,508,171	12,268,205
1976	3,043,430	7,620,016	4,716,000	3,840,138	9,941,000	11,460,154	6,883,568	14,657,000
1975	4,565,256	11,430,303	5,875,000	7,955,600	8,029,000	19,385,903	12,520,855	13,904,000
1974	3,635,179	9,101,613	3,326,000	5,356,906	5,194,000	14,458,519	8,992,085	8,520,000
1973	8,822,258	22,088,811	8,146,913	12,619,157	10,117,806	34,707,968	21,441,415	18,264,719
1972	12,748,863	31,920,086	8,211,502	16,731,143	10,791,970	48,651,229	29,480,006	19,003,472
1971	5,749,397	14,395,107	3,520,455	19,971,075	8,227,869	34,366,182	25,720,472	11,748,324
1970	6,500,741	16,276,291	3,981,512	18,213,172	8,123,829	34,489,463	24,713,913	12,105,341
1969	8,477,687	21,226,088	4,592,814	20,093,353	8,563,307	41,319,441	28,571,040	13,156,121
1968	10,939,613	27,390,159	4,401,394	18,082,414	5,626,637	45,472,573	29,022,027	10,028,031
1967	8,376,775	20,973,429	3,378,410	15,567,042	4,836,875	36,540,471	23,943,817	8,215,285
1966	5,699,009	14,268,947	3,078,532	19,495,646	7,530,880	33,764,593	25,194,625	10,609,412
1965	5,941,954	14,877,223	3,653,100	21,653,171	7,514,509	36,530,394	27,595,125	11,167,609
1964	5,568,841	13,943,264	2,619,526	22,560,324	6,209,303	36,503,588	28,129,165	8,828,829
1963	1,908,063	477,732	878,558	4,114,667	1,230,597	4,592,399	6,022,730	2,109,115
1962	7,169,028	17,949,812	3,445,572	24,777,341	8,201,505	42,727,153	31,946,369	11,647,077

Source: United States Bureau of Census, Imports For Consumption.

[1]Greenland halibut imports may be removed from the data by referring to Table 40.

[2]The conversion from fillet to dressed weight was derived from sets of relations used by the National Marine Fisheries Service to convert to round weight.

TABLE 51

TEN-CITY AVERAGE OF RETAIL PRICE PER POUND
OF HALIBUT STEAKS BY MONTH AND YEAR (1973-1978)
(In Dollars)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.	σ	Avg. CPIF	Avg. CPI MP&F
1973				1.68	1.86	1.83	1.76	2.15	2.05	1.96	2.00	2.06	1.93	.15	1.19	1.20
1974	2.05	2.07	2.10	2.05	2.14	2.08	2.01	2.05	1.80	2.20	2.13	-	2.06	.10	1.10	1.26
1975	2.28	2.09	2.12	2.17	2.26	2.17	2.23	2.36	2.14	2.46	2.33	2.80	2.28	.20	1.12	1.28
1976	2.80	3.00	2.91	2.70	2.86	2.83	2.92	2.96	3.01	2.90	3.29	3.91	3.01	.32	1.32	1.68
1977	3.66	3.28	3.05	3.27	3.34	3.31	3.37	3.48	3.57	3.50	3.39	3.55	3.39	.17	1.35	1.90
1978	3.51	3.69	3.76										3.65	.13	1.37[1]	1.94[1]

Sources: NMFS Operation Price Watch of Ten Major Cities, started in April 1973 include: Atlanta, Boston, Little Rock, Galveston, Los Angeles, Pascagoula, San Francisco, St. Petersburg, Seattle, and Washington, D. C. Other data sources from U. S. Department of Labor Statistics Handbook of Labor Statistics, 1976, Wholesale Prices and Price Indices data for 1976, 1977, and January of 1978.

[1]Seasonally-adjusted CPI indices for January 1978 were used to adjust 1978 average prices.

Fishermen and processors of halibut expressed concerns about the market takeover of the more abundant Greenland "halibut" as early as 1928. An increasing quantity of Greenland halibut was being shipped to the U.S. in the early 1960s under the name "halibut." In 1967, the FDA declared that Greenland halibut would not be marketed in the U.S. under the name halibut, but would be called turbot. In 1960, the Halibut Association of North America started nationwide advertising campaigns to emphasize the difference between halibut and other fish species in order to secure a market identity and thereby reduce incidence of price substitution. One of the marketing methods employed a comparison of the nutritional values of Greenland halibut and Pacific halibut and the cooking and flavor characteristics that both fish have. This marketing effort was designed to point out halibut's unique characteristics and to establish enough product differentiation to enable the halibut market to find its own price with a minimum of substitution effects. The advertising campaigns may be partly the reason that the retail, wholesale, and exvessel prices of halibut have been strong in the face of increased imports of fish blocks and Greenland turbot. However, it seems that effective retail marketing cannot totally explain the high retail, wholesale, and exvessel prices that are currently enjoyed by those involved in the halibut fishery. Since the Halibut Association of North America is now relatively inactive and local, one must look to other explanations. Further discussion on the reason for these high prices must encompass several other factors that traditionally have determined the consumption of a food and consequently its demand.

Marketing Channels

As was stated previously, the processing of halibut is closely related to its distribution because:

1. Shipping whole frozen halibut in bulk to distant markets saves freight costs.

2. Keeping the halibut in a whole form helps preserve quality.

The restrictions on distribution modes are, therefore, contingent on present processing methods. As with other agricultural products shipped in bulk, transportation costs eventually become an important factor, and ultimately become a determinant in the distribution of the product.

A comparison of market channels in 1923 and 1977 was made through the cooperation of several large processors in Alaska and also by consulting work on the distribution channels of halibut by L. T. Hopkinson for Pacific Fisherman in 1923. In 1923, distribution was done by railroads. The containerized/trucking industry has diminished the need for rail transport. It is also apparent that Seattle is no longer a primary point of aggregation for halibut. The most important final destinations in 1923 appear to have been the New England states, the Great Lakes region, the Southeast and, of course, the Northwest and West Central states.

The market channels of 1977 are quite different in many respects mainly because the major primary aggregation points for the product have shifted from Seattle to Alaska. This has caused some marketing arrangements that were not evident in 1923. Halibut is usually received by processing plants or buying stations in Alaska from the halibut vessels. The use of tenders or steamers is rare. The plant that receives the halibut may act as an independent buyer or an agent for another firm, such as a cooperative (Antonelli 1978).

The result of the initial processing procedure is a whole, headed, frozen, glazed fish. At this stage the fish is termed "semi-processed." The product that is processed in Alaska may be bought by an independent processor in the lower states (usually Seattle) or, the product may be custom packed by a secondary processor for the company that originally received the catch (Jensen 1978). Another alternative is a situation where a company may own plants both in Alaska and Seattle, and will reprocess and distribute the semi-processed halibut from Seattle. Shipment of fish, as with other agricultural products, has been affected by containerization and use of trucks instead of rail. The box or tote of fish is now either trucked out or placed in freezer containers, or vans, placed on barge or freighter, and sent to a major U.S. city for processing, usually Seattle.

Air freight, although used in the fresh market from Seattle, is seldom used for transport from Alaska. Alaska had been moving towards marketing frozen halibut (Jensen 1978) and the freezing eliminates the need for air freight. Appendix VIII shows the changes occurring in production patterns from 1950 to 1976. Note the increase in the incidence of frozen halibut to the exclusion of other product forms.

Since transportation costs ultimately determine the amount of halibut the secondary processors will supply at a given price, the west has a stronger market than the east (Jensen 1978). Los Angeles has become more important as an outlet for halibut than the more traditional Boston/New York markets.

The market channels described in Figure 16 confirm the observations that the members of industry have made. The market channels discussed here represent 56 percent of the total production of Alaska derived from the sales of both Canadian and American fishermen to Alaskan ports. Most Alaska processors finance their own buying activity and ship frozen whole halibut by containerized cargo carriers to Seattle.

Demand and Projections

Demand

Bell et al. (1971) have investigated the world demand for halibut. However, their analysis is dated, and their results are difficult to interpret, because of some of their assumptions they used in the formation of their models.

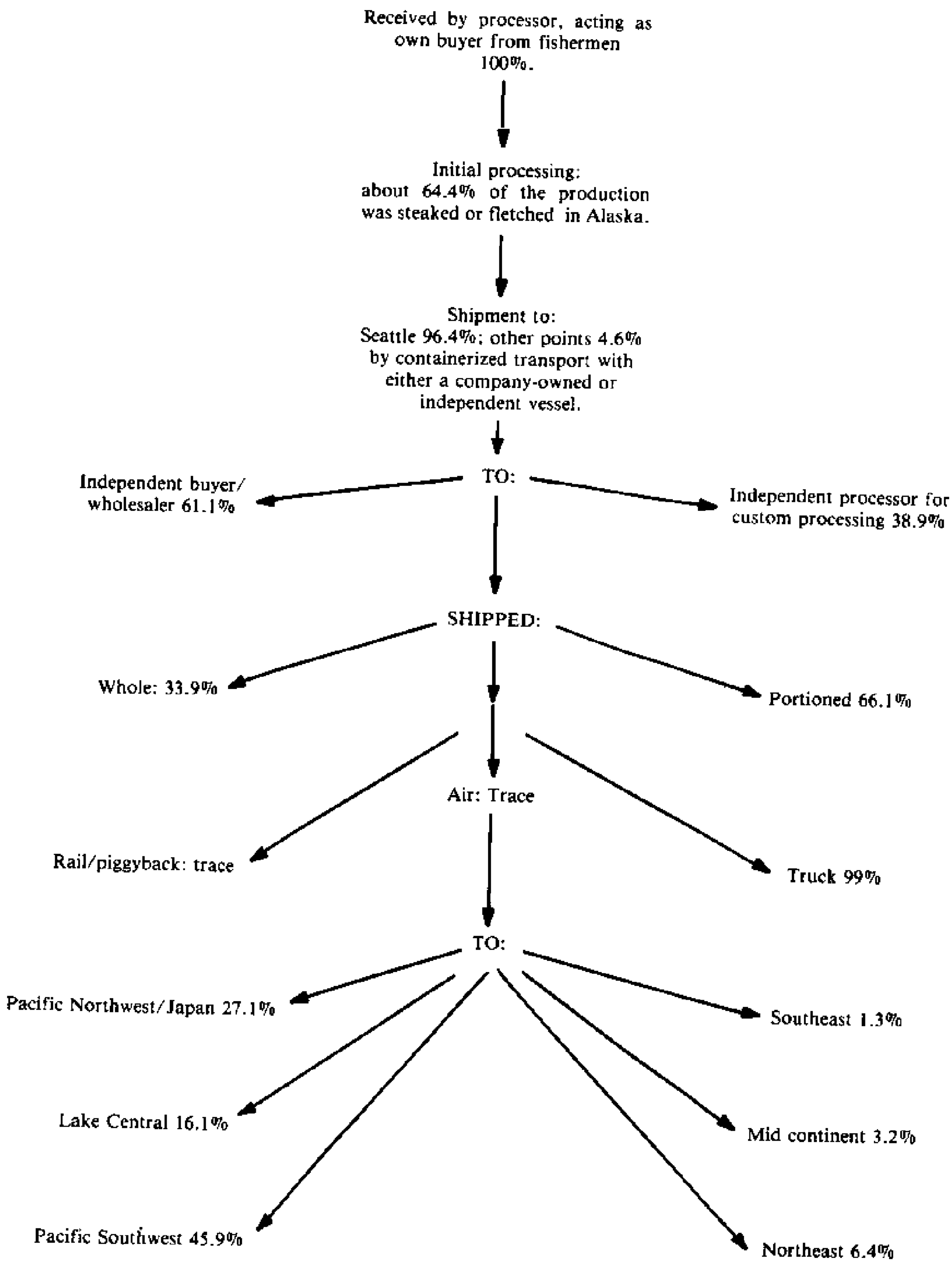

FIGURE 16. MARKET CHANNELS FOR ALASKA PRODUCED HALIBUT, 1977

Instead of reiterating their work, we present here a review of economic theory, and we will fit what is known about the halibut fishery and the consumer demand for halibut into this framework.

Table 52 describes some of the components that are necessary to arrive at per capita consumption, a crude indicator of demand. Per capita consumption may be a function of several factors not specifically identified by the table, but are nonetheless necessary for a complete theoretical treatment:

$$Q/X = f(P_q, [Y/X]_R, P_s, \emptyset)$$

Where: Q = the total quantity of halibut consumed in a period of time or in a particular area

X = the total population in residence at any time or in any area

P_q = the real unit price of halibut, retail

P_s = the real unit price of substitute, retail

Q/X= per capita consumption

$(Y/X)_R$ = the real per capita average income, which can be approximated by various Consumer Price Indexes.

$\emptyset$ = the consumer's tastes and preferences.

The unit prices and income should be deflated by an appropriate index if the demand is estimated through time. The components of per capita consumption are interesting to look at in themselves. One would expect the per capita consumption to decline with an increase in real price per unit, and this did happen (Table 52). However, several other occurrences have helped to bring about this decline in the face of an increased price:

1. The total resident population of the U.S. has increased some 19.5 percent from 1960 to 1976.

2. The total consumption has decreased some 67.5 percent from 1964 to 1976. This seems to parallel the following occurrences in the industry:

    (a) From 1960 to 1976, the IPHC decreased their halibut quotas by 55.75 percent.

    (b) As a rsult of (a), the actual catch in IPHC management areas decreased by 61.55 percent from 1960 to 1976.

TABLE 52

LANDINGS (DRESSED WEIGHT) BY MAJOR REGION, IMPORTS (PRODUCT WEIGHT), INITIAL AND FINAL COLD STORAGE HOLDINGS (PRODUCT WEIGHT), POPULATION, TOTAL APPARENT CONSUMPTION AND PER CAPITA CONSUMPTION BY YEAR FOR THE UNITED STATES

Year	Alaska [1,2]	Other Pacific Sources [1,2]	East Coast [1]	Imports for Consumption	First of Year Holdings	Last of Year Holdings	Total Consumption	Total Resident Population	Per Capita Consumption
	X 1000								
1960	23,437	20,182	203	27,364	17,830	13,667	75,349	179,979	.4187
1961	25,930	16,730	214	26,455	13,667	12,944	70,052	182,992	.3828
1962	32,668	16,782	191	31,946	12,944	21,431	73,100	185,771	.3935
1963	28,718	16,011	205	6,023	21,431	23,885	48,503	188,483	.2573
1964	21,581	11,978	231	28,129	23,885	14,699	71,105	191,141	.3720
1965	28,354	8,643	247	27,595	14,699	16,469	63,069	193,526	.3259
1966	28,856	8,153	231	25,195	16,469	19,801	59,103	195,576	.3022
1967	25,533	10,444	220	23,944	19,801	17,917	62,025	197,457	.3141
1968	13,488	12,670	189	29,022	17,917	12,629	60,657	199,399	.3042
1969	21,151	9,820	159	28,571	12,629	13,844	58,486	201,385	.2904
1970	26,087	7,367	149	24,714	13,844	16,069	56,092	203,810	.2752
1971	23,911	4,942	185	25,720	16,069	10,616	60,211	206,219	.2920
1972	23,340	2,726	167	29,480	10,616	16,873	49,456	208,234	.2375
1973	19,703	2,153	144	21,441	16,873	15,515	44,799	209,859	.2135
1974	13,624	1,168	87 [3]	8,992	15,515	7,909	31,477	211,389	.1489
1975	17,985	1,605	86 [3]	12,521	7,909	7,573	32,533	213,032	.1527
1976	16,926	1,095	102 [4]	6,884	7,573	8,132	24,448	214,649	.1139

Source: U.S. Bureau of Census historical data and supplements; U.S. Bureau of Census *Imports for Consumption*, various years; U.S. Department of Commerce *Current Fishery Statistics*, 1975 and 1976; *Food Fish Market Review and Outlook*, by month; 1967 Statistical Digest; International Pacific Halibut Commission landings by year and major port.

[1]Dressed weights have been used.

[2]These figures include landings made by British Columbia ships in the United States.

[3]These figures have been obtained by subtracting the U.S. landings of halibut in the North Pacific from total halibut landed by the U.S.

[4]1976 East Coast catch was obtained from the International Commission for the Northwest Atlantic Fisheries Statistical Bulletin, Vol. 26.

(c) Also indirectly as a result of (a), imports (mostly from Canada) decreased 78.45 percent from 1962 to 1976.

3. The real wholesale value per pound of halibut in New York has increased about 1.66 times since 1960, as was shown in Table 48. The real ten city average increase for halibut from 1973 to 1976 alone was 40 percent, as Table 51 shows.

The other four variables (real income, prices of substitutes, prices of compliments, and consumer tastes and preferences) must be assumed static in order to look at consumption relative to the price of halibut.

Developments 1. and 3. point to the possibility that industry supply, which has gradually been curbed by quotas, is moving up a demand schedule. Incidentally, no one has adequately measured this demand schedule, and, therefore, statements about its shape can only be made with existing non-quantitative data. However, there are indications that the equilibrium lies in the elastic portion of demand.[2] It should be expected, then, that any percentage change in price in this area will yield a proportionately greater change in quantity demand. The industry equilibrium that has existed since the mid-1970s seems to be in the elastic portion of demand in light of the following information:

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[2]Elasticity (E) in this case refers to the percent change in the quantity demanded that one can expect from a given percent change in price when other variables (income, inflation, tastes, preferences, and population) are held constant. The elasticity of demand is an important consideration when discussing total and marginal revenue available to the industry. The elasticity may be anywhere from 0 to negative infinity. The negative number simply means that there is an inverse relationship between price and quantity. With a few exceptions, most demand curves will possess three regions: one region, usually in the range of higher prices, is the area of elastic demand, or where $|E|>1$. That is, a given percentage change in price up or down will yield a proportionately larger change in quantity demanded. In this area, total revenue increases as price decreases and marginal revenue decreases as price decreases. The next area of interest is unitary elasticity of demand, or where $|E|=1$. Here total revenue to the industry is maximized and marginal revenue is 0. The next area is in the realm of lower prices and is the inelastic portion of demand or where $|E|<1$. Here, as price decreases, total revenue decreases and marginal revenue is negative. For the industry as a whole, this is an undesirable place to be. Some demand curves, because of the conditions that make up their shape, are easier to lose revenue on than others. That is, there is less room for big adjustments in supply across some demand curves. This is illustrated farther on in the text.

brium that has existed since the mid 1970s seems to be in the elastic portion of demand in light of the following information:

1. There are potential substitutes for halibut, in both fish and, especially, beef. The price range of meat substitutes is large, thereby making substitution a real threat to halibut sales.

2. There are even more potential substitutes waiting in the wings in the form of new fisheries development. The federal government's policy stance advocating low food prices at the consumer level keeps other meat, especially beef and poultry, strong competitors.

3. Consequently, the population that consumes halibut is probably small relative to the population of the U.S. and tends to be in higher income groups. Halibut has been called a luxury item, according to some researchers (Pigot 1978).

4. The industry supply function is flattened over the relevant range (equilibrium with consumer demand) by catch quotas imposed by IPHC. Industry-wide price equilibrium with demand appears to be moving in the direction of decreased total revenue in recent years.

5. Despite all of these things, the U.S. is the major world consumer of halibut. About 60 percent of the world catch as recorded by FAO in 1976 found its way into the U.S.

These points would lead one to believe that the equilibrium is in the elastic portion of the demand curve. However, one must also ask what the shape of that demand curve is: Although most demand schedules have areas of unitary elasticity, inelasticity and elasticity, the position of the demand curve in space is another matter.

Figure 17 illustrates this point. A typical condition that would produce a demand curve such as DD in Figure 17 would be a limited consumer base, which may be due in part to changing tastes and preferences, non-aggressive advertising, or any other situation where a consumer will in some way lose contact with the product, will not be able to identify it, or can never find it when he wants it in the "right" product form. This demand schedule, DD, does have a position where total product is maximized. The industry does fare well[3] in this portion of the demand curve. However,

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[3]A vertical supply curve is used for the industry to signify the effect of quotas set by IPHC. This is not strictly true for the whole industry since intertemporal trading is carried on. Transactions, therefore, are not instantaneous or costless. For each firm, its exact position of equilibrium with consumer demand will depend on its own cost structure. As the situation approaches perfect competition (many buyers and sellers), the individual firm may view consumers' demand (through his buyer) as infinitely elastic, or a horizontal line. In this case, total revenue is maximized by achieving economics of scale.

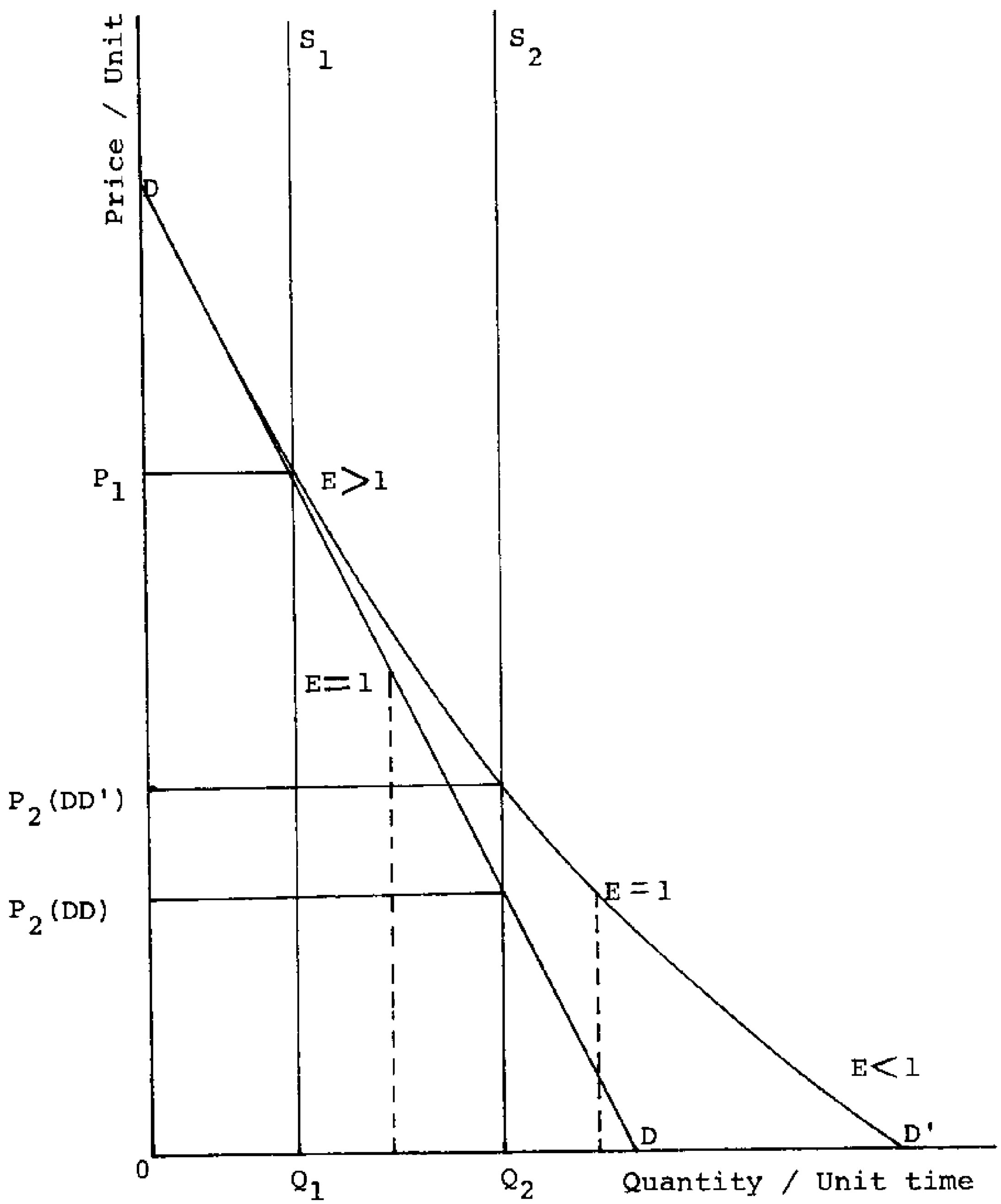

FIGURE 17. AN "INELASTIC" DEMAND SCHEDULE DD, AND AN "ELASTIC" DEMAND SCHEDULE DD', WITH AREAS OF ELASTICITY AND THEIR RELATION TO INDUSTRY SUPPLY AND PER UNIT PRICE

increasing the consumer base to produce the schedule DD would place the point of unit elasticity or, the point where industry revenue is maximized, further out on the quantity axis and increase the total revenue available for exploitation as well as provide a cushion against unforeseen changes in supply. This property of demand DD' over DD becomes very critical, depending on the expectations about the well-being of the resource.

Projections

Reasons have been given in previous sections to believe that the supply curve of the industry already lies in the region where marginal revenue is positive and where, if a sufficient additional quantity could be obtained, total revenue to the industry could be maximized. An example of this is shown in Figure 17 with Supply (S_1) intersecting DD at an equilibrium price of P_1 and a quantity of halibut restricted by quota of Q_1.

In this case, however, industry is constrained at Q_1 and, as a result, to P_1. In this situation the production of a smaller quantity than the quota leads to decrease in total revenue.

Therefore, if the fishery contracts because of further quota reductions, a response of industry could be to increase the demand for halibut (shift the curve DD out and up) through a more aggressive advertising campaign. This activity will become critical as the halibut fishery approaches economic extinction, since an outward shift in demand will contribute to an increase in the total revenue. This is not an unrealistic suggestion since, along with the population, the average real per capita disposable income of U.S. citizens has been steadily increasing (Table 53).

If management succeeds in staging a comeback of the halibut fishery, this will imply some economic cost decrease for the harvesting and processing sectors. However, if demand stays unaltered, as illustrated by DD, through an increase in the quota (S_2), total revenue available to the industry might very likely decline rapidly along with price. This would place the industry in the inelastic portion of demand, and in a position where total revenue is as little or less than when supply was more highly constrained (S_1). This would be especially true in a situation where a glut might occur in inventory. Again, in the advent of a successful fishing year, advertising aimed at increasing the consumer base seems to be a desirable reaction. Figure 17 again illustrates this.

Since statistics imply that more disposable income is available than ever before (Table 53), it seems that a substantial number of people might be won over to halibut, which would shift demand to DD'. As supply shifts out, price decline along DD' would be less rapid and, in fact, total revenue would actually be increased. The point to be made is that advertising, simultaneous to supply increases, is desirable to maintain an optimum position on the consumer demand schedule. The major

TABLE 53

PER CAPITA DISPOSABLE INCOME IN 1972 DOLLARS
FROM 1950 TO FIRST QUARTER 1978

Year	Per Capita Income	Year	Per Capita Income	Year	Per Capita Income
1950	2,386	1960	2,697	1970	3,619
1951	2,408	1961	2,725	1971	3,714
1952	2,434	1962	2,796	1972	3,837
1953	2,491	1963	2,849	1973	4,068
1954	2,476	1964	3,009	1974	3,981
1955	2,577	1965	3,152	1975	4,014
1956	2,645	1966	3,274	1976	4,137
1957	2,650	1967	3,371	1977	4,293
1958	2,636	1968	3,464	1978	
1959	3,696	1965	3,515	[1]	4,401

Source: *Economic Report of the President*, January 1976, *Federal Reserve Bulletin*, May 1978.

[1]1978 estimate is for the first quarter of the year.

factor that militates against successful application of advertising to U.S. consumers is the American tastes and preferences. The unfortunate truth is that Americans eat other meats much more than they do finfish, even though they will admit that fish is desirable from a nutritional standpoint (Table 54). In addition to this, there are so many other fish items to compete against, and some are regionally eaten and, in fact, may even be preferred over the more expensive halibut. The result is that, while halibut may make modest gains in demand through an income rise/exotic food effect, most Americans in the mood for fish may just buy a fish sandwich made from less expensive fish, which they regard as just as tasty; or they may change their minds and buy a hamburger or a steak. An encouraging note is that the American public is dining out more often and, according to Gillespie and Schwartz (1977), this change in behavior patterns has eliminated at least two stumbling blocks that consumers invariably hit when buying seafood; inconvenience and ignorance of preparation methods. A discouraging note is that increases in the incidence of fast-food fish restaurants that sell a fish product other than halibut may win a number of consumers that would otherwise spend a little more money in an establishment serving halibut.

At any rate, increasing the consumer base, using industry-wide advertising in both cases, would seem to be a desirable activity. The situation now, where limited supplies of halibut make it less expedient to reach more consumers by being aggressive in marketing, may lead to the erroneous assumption that such a marketing position might be valid in the future.

Summary

The halibut resource appears to be in a serious condition. It shows an almost constant decline since the late 1950s in all areas. Although regular halibut boats are declining in number, there is evidence that the fleet of smaller vessels has increased. Technological enhancements of the classical effort variable (skates), have tended to increase the efficiency of boats and, coupled with boat versatility, have made the fleet hard to identify. Foreign and domestic bottom trawling operations have been blamed for reducing the stocks of halibut through incidental catches. Although domestic trawlers are required to return these halibut to the ocean by IPHC law, the usefulness of the rule is questionable at best, according to studies that indicate high mortality (50 percent or higher in foreign trawl caught halibut) of incidentally caught halibut (Hoag 1975). The damage has been done by non-specific gear types that tend to take smaller halibut. An inefficient use of the resource is painfully evident, regardless of whether the fish are kept or thrown back. This is uncontrollable by conventional fishing gear technology and with the recent interest in bottomfish development, it seems clear that the development of trawl technology will cause a further depression of the halibut fishery, unless the information on stock location supplied to managers is sufficiently unbiased to truly allow multiple use by gear types with overlapping target areas but with different efficiencies. The only available methods for control are area and time closures.

TABLE 54

CONSUMER ATTITUDES TOWARD SEAFOOD AND SUBSTITUTE MEATS

"About how often do you prepare each of the following?"

Meat Item	Percent Preparing 2 to 3 times a month:
Beef	97
Poultry	88
Pork	67
Canned Seafood	45
Finfish	31
Shellfish	16

"On your next visit to the store, how likely is it that you will buy each of the following foods?"

Meat Item	"Definitely" or "Likely" to buy:
Beef	94 percent
Poultry	92
Canned Seafood	66
Finfish	34
Shellfish	21

	"It's Nutritious" Percent	"It's Easy to Prepare" Percent	"It's Economical" Percent
Beef	95	86	43
Pork	65	78	40
Poultry	91	76	65
Fish	94	66	61
Shellfish	87	72	30

Source: Gillespie and Schwartz (1977).

In recent years, the halibut fishermen have enjoyed what some have termed a "seller's market" due to the unusually small amount of halibut that may be caught under IPHC quotas. However, the possibility of large export or domestic markets of presently underutilized species may reduce the competitiveness of halibut buying, and result in a situation where halibut must compete for storage space with other species. The result may mean substantial price declines, especially if the volume and regularity of other fish species become such that they compare favorably to the smaller catch volume of halibut. Finally, diversifications into other fisheries may further reduce halibut supply, and continue to diminish the halibut fishery's importance in Alaska.

In summary, the following statements seem to appropriately describe the halibut fishery:

1. Gear restrictions accelerate technological improvement of the restricted gear type and auxiliary inputs, and are reflected as capital intensive tendencies among boats. Planning horizons and life of capital equipment are based on the historical condition of the fishery, not the condition in the long run. Therefore, harvesting and processing capacity may exceed the need in the long run. The life of large-sized capital equipment may outstrip the level of the resource that would yield least-cost operation, thus the fishermen and processors must either use other resources or exit the industry. From the standpoint of the fishing industry as a whole, excess capacity, once generated, becomes chronic (Crutchfield and Zellner 1963).

2. The subjective grading of halibut has historically tended to vary with the strength of actual market demand for halibut, rather than being totally determined by strict criteria. The advantage lately has been with the fisherman, because of reduced halibut quotas.

3. The processing methods of halibut follow roughly the same procedures as other fish, and, therefore, the equipment may be used to process other fish species. Excess capacity in processing does not seem to be a problem except in cases where all fisheries are experiencing tight years.

4. The IPHC appears to have been instrumental in bringing about the recovery of the fishery from its previous low in 1931. However, its management power has become more limited, and the halibut fleet is less easily defined. This causes problems in data collection and effective enforcement of regulations.

5. Price ceilings and port allotments set by federal government during times of war or national emergency must be well thought out, synchronized with other management agencies, and implemented with special attention given to economic considerations important to fishermen and processors, such as transportation costs (including opportunity costs of running time), season

length, price discovery mechanisms that are singular to the fishery, and processing capacity in different areas of the coast. Historical cases have shown a disregard for these logistical parameters (Pacific Fisherman 1946).

6. There has been a dispersion of the exvessel halibut market north towards Alaska and northern British Columbia. The auction system, which was popular up to the late 1960s in Seattle, has been replaced by negotiations directly between buyers and fishermen. Price information is no longer easily obtained and, when it has been, these prices do not include bonuses that processors pay to fishermen.

7. Halibut is processed at various stages along its distribution, and as a result, the original processors have only limited product control. Methods of retailing, also usually not under the processors' control, are sometimes not suited to the marketing of fish, as in the case of some supermarket outlets.

8. Income effects may tend to keep halibut prices high. That is, because there have been increases in the average real per capita income in the U.S. and some other countries abroad, and since halibut is a "luxury item" fish and has gained the reputation of a gourmet item through advertising, it is reasonable to expect that as a person's income increases, he may look to other, less common foods such as halibut for enjoyment.

9. Exvessel prices presently reported are incomplete and may not reflect the true market value of halibut. Bonuses and services to fishermen from processors that raise the cost of the raw product to the processors are usually omitted from price quotes. As a result, any economic analysis may be less reliable in recent years because of the inability of exvessel price to reflect the working of the exvessel market. Two possibilities could be explored for establishing the extent of price distortion: (1) if the activities of bonuses have increased as a function of time, any price-predicting equations formulated under an auction system in history should gradually fail to predict price in dispersed markets in later years as a direct function of the extent of bonuses given; and, (2) obtaining the amount of bonuses paid directly from the processing sector.

10. Seasonal cold storage inventories play a large role in the financial success of fishermen. In the past different grades of halibut commanded their own price according to their own abundance, cost of processing, and consumer demand. Grading at the exvessel level appears to be flexible according to abundance of catch and the availability of cold storage inventories. Exvessel halibut prices are particularly affected by speculative activity in the wholesale market. "Sticky" retail or wholesale prices, caused by an incomplete knowledge of consumer demand, have historically occurred and have in the past caused unexpected gluts or decreases in the inventory of halibut that affected exvessel price accordingly.

11. Historically, season lengths have affected the distribution of the raw product. Short seasons have historically benefited those processors that are closest to the most productive grounds. Short seasons have also tended to induce small boats from other fisheries to temporarily enter the halibut fishery during closed seasons in other fisheries, thus intensifying local effects. Mandatory tie-ups of long periods (the split season) tend to induce fishermen to return to their home ports to transact business. Voluntary tie-ups fail in the case of a dispersed fishery of small non-union, independent fishermen. Short or poor seasons tend to depress the fish available to the fresh local market.

12. There is an exvessel price differential between Alaska and points south that reflect transportation and other operating, marketing, and distribution costs. Alaska exvessel prices are lower because buyers at the wholesale level must be induced to bear transport costs. On the whole, exvessel prices paid in Prince Rupert may be higher due to the rail terminal advantage, as well as the existance of the Prince Rupert Fisherman's Cooperative. Seattle markets tend to offer higher exvessel prices to induce fishermen to sell there.

13. There is presently little or no halibut exported from the United States to other countries. The U.S. is the major world consumer of halibut.

14. In the face of a decreasing resource, prices will be maintained at very high levels, unless there is an entry of likely close substitutes. Halibut as a luxury food, however, competes with a number of other food products of the same class. One of the major competitors is beef. Halibut also tends to be a product that is served in restaurants that would not be considered "fast food" and, as a result, the fishery may get no help, and may even be hurt by the increase of "fast food fish places." Demand creation through advertising the uniqueness of halibut would strengthen the overall position of the fishery. In the face of an increasing resource, prices will fall rapidly, causing a loss in total revenue to the industry. The principal reason for this expected price collapse is a small consumer base due to low-key advertising, small quotas and a limited outlet to consumers. The remedy for this problem is the anticipation of an increasing resource, and an aggressive marketing program aimed at building the consumer base and use patterns of halibut, as well as emphasizing uniqueness of the product. Carefully-planned discriminatory decreases in price based on a firm knowledge of the aggregate demand of hailbut <u>after</u> consumer base has been built will result in increased total revenue for the industry.

The halibut fishery is, therefore, at a management and marketing crossroads and at the mercy of other fisheries, as well as the management policies put forth by responsible bodies that affect foreign fishing in U.S. zones of the North Pacific and Bering Sea. It seems that the resource is not necessarily dwindling because of the halibut fleet or the failure of the IPHC to carry out its specific charge, but rather from other factors outside the managment system specified by the two governments of Canada and the United States. In this sense, a significant proportion of the resource and its use lies outside present management control.

CHAPTER VII

HISTORY OF THE HERRING FISHERY

Early History

The Alaska herring fishery was based on three sources of demand (Rounsefell 1930):

1. Products of reduction, including oil and meal. The oil from herring and other industrial fish was used to produce a variety of products including paint, soap, margarine, and feed supplements. Meal was used as fertilizer and later as a feed supplement for poultry and cattle.

2. Food products that used the body of the herring. This activity led to direct competition with European sources of supply. Products for human consumption were Norwegian cure, Scotch cure, smoked or kippered, hard salted, and canned products of various types. These products now play only a minor role in the herring fisheries of Alaska.

3. This market historically paralleled the expansion of first the halibut, and later, the crab fishery.

Although Wrangell had an oil rendering and saltery operation as early as 1878, and Kodiak Island produced a quantity of smoked and cured herring in 1880 (Cobb 1905), the first plant in Alaska to exploit the herring fishery exclusively was based in Killisnoo on the upper Chatham Strait in 1882. It was the only herring reduction plant in Alaska until 1919 (Rounsefell 1930). The reduction fishery expanded from its base in Chatham Strait. In 1920 Prince William Sound had two reduction plants and Southeast Alaska added six. By 1927, there were 25 herring reduction plants in the territory--18 large plants in southeast Alaska and seven smaller plants in Prince William Sound (Rounsefell 1930). All of these original companies were vertically integrated so that the catching, processing, and shipping businesses were all owned by the same company.

The peak of the herring industry occurred in the mid 1920s when 150 million pounds of herring were processed. These first plants were highly specialized operations that drew their raw product from a localized area because: 1. the resource base was abundant, 2. plants were usually in a state of undercapacity, and 3. vessel and refrigeration technology in 1911 constrained the vessel range. The poor keeping quality of herring in the round restricted voyages to a radius of about 50 miles (Rounsefell 1931).

Origins of the Alaska herring fishery seem to have been derived from Northern Europe. Until 1924 the plant at Killisnoo used a Norwegian method of seining for herring. Two dories powered by oar were used to encircle a school of herring with a net that was approximately 125 fathoms in depth (Rounsefell 1931). The boats met in a full circle, pursed the seine by hand, and brailed the herring on board a steamer.

Set and drift gillnets were also used around the Shumagin Islands, in Halibut Cove, and Prince William Sound (Rounsefell 1930).

Since the size of herring determined its uses, and these different size variations were largely regional, there were regional differences in types of herring products. Reduction plants were located in Southeast Alaska where the herring were too small for human consumption, yet were fat enough in season for high yields in reduction processes.

The relatively non-selective purse seine was well suited to the reduction industry since size of the fish was not a major consideration. Areas that later became noted for curing of herring usually had an abundance of fat herring that were over ten inches long. This was important because the size of the herring determined the grade or quality of the pack. As a result, the herring fishery was concentrated either in Southeast Alaska, Prince William Sound/Cook Inlet area or the Kodiak/ Aleutian region. Although all of the areas tried their hand at curing herring, the Kodiak/Aleutian area had the natural advantage of larger fish. Likewise, though all of the processors eventually produced bait in quantity, Southeast Alaska was, and still is, recognized as the area producing the best quality bait. All areas seem to have engaged in at least some herring reduction, though most of the reduction industry was in the Southeast.

The most interesting development in the history of the herring fishery were the attempts of the Fish and Wildlife Service in 1917 to introduce a new method of cure, called the "Scotch cure", through an industry-wide educational program. The original method of curing (pickling) was the Norwegian method which called for heavy salting of the whole fish in a barrel or tierce. However, Alaskan fat herring caught during their feeding season (summer to fall) usually contained a large quantity of plankton called "red feed." This tended to turn the cure sour. Attempts to alleviate the souring problem included holding the fish in ponds prior to curing to allow them to void this red feed. This additional step raised the cost of production to a prohibitive level. However, the introduction of the Scotch cure method by H. Klie called for the removal of the gill and gut ("gibbing" or "gipping"), a more careful grading of the fish with respect to size, and packing them tightly in barrels or tierces (Bower and Aller 1918). This method of curing, actually a Dutch process, involved not only this phase, but also a system of repacking, grading, and certification, which in Great Britain and most of Scandinavia was standardized by law as early as the 1600s (Hodgson 1957). This highly developed processing system is probably the reason that the British Isles and Iceland were such effective competitors with Alaska, both in quantity and the quality of their own pack. Despite the West Coast trade disadvantage (repeatedly stated in Pacific Fisherman as labor and transportation costs), an impressive technology arose around the herring reduction and food fish industry. In 1932, the London Fish Company of Vancouver, B. C., installed a herring-splitting machine thereby making much easier the process of producing headless, boneless kipper.

As early as 1906, protests against reduction of herring oil and fertilizer were carried to the U.S. Congress. This activity played a role in prompting the first attempts by Congress to enact legislation regarding Alaska's fisheries. The first such law was the Act for Protection and the Regulation of the Fisheries of Alaska. In addition to this Act, the Act to Prohibit Aliens from Fishing and the Pure Food and Drug Law had application to Alaska fisheries and also to herring. However, the terms of the 1906 Fisheries Act was general and aimed primarily at the salmon fishery. Enforcement of the applicable laws to other fisheries played at best a secondary role. The Bureau of Fisheries position, despite the weak content of the laws of 1906, was summed up by Evermann (1913):

> There is a need of regulation and the prevention of wasteful practices in the herring fishery even as in the case of the salmon fishery, notwithstanding that the runs of herring are heavy and that their prolific breeding habits make the danger of depletion less imminent.

A series of legislation ensued between 1920 and 1924 and assured that the desires expressed in the above quote came true. The question of whether or not to allow herring reduction was shelved. Grumbling from the fishermen ceased when more processing firms supplied bait on a regular basis. The structure of the industry remained intact for the time being. It disintegrated later because of stock depletion and uncontrollable changes in the raw material requirements of production processes using herring products. The more technically efficient operations of Scotland, Norway, Iceland and Newfoundland served to undermine Alaska's bid for the limited demand of the American consumer.

Management History

It is not surprising that the management of the herring resource had its beginnings in the Protection and Regulation Act of 1906. The original laws were aimed at the salmon fishery, the most prominent of Alaskan fisheries. These laws, however tangential in application to the herring fishery, involved the collection of fish-house taxes and fishing taxes. A cursory examination of these taxes shows, for example, that for all boats and processes in 1913, the annual tax of a fishing boat in excess of 30 net tons was $1 per ton (Evermann 1914). The processing tax in the same year ranged from $10 to $500, depending on the level of production. Apparently no discrimination was made for herring fishermen and processors. Amendments aimed at salmon fishing occurred in 1916: in 1918 a territorial license tax was enacted (Bower 1920). In 1920, a tax of 2 cents per case of canned herring was enacted (Bower 1921), but in 1923 this tax was repealed. In its place a 40 cents per barrel tax on oil and a 40 cent per ton tax on meal was enacted, ostensibly to discourage entry into reduction activities. However, the bulk of the regulatory activities that developed were centered on the prevention of wanton waste, prohibition of fishing activities that were deemed unorthodox or dangerous to the stocks, and enforcement of the weekly closures from 6:00 p.m. Saturday to 6:00 a.m. Monday. However, on June 6, 1924, the nature of regulatory activities changed with a new set of amendments to the Act of 1906, and a regulated herring fishery, as it is known today, came into existence with the following enabling clauses vested in the U.S. Secretary of Commerce:

The Secretary of Commerce may:

1. Fix size and character of nets, boats, traps or other gear and appliances to be used therein;

2. Limit catch of fish to be taken from any area;

3. Make such regulations as to time, means, method and extent of fishing as he may deem advisable.

Subsequent regulations for specific activities and areas were enacted on June 21 of the same year and again on December 2 in anticipation of the 1925 fishing year. Regulations included gillnet mesh size (usually of three-inch stretch mesh), closed seasons and quotas. In this respect the management techniques then were about the same as they are today.

It is also of historical interest to note that the Bureau of Fisheries played an active role in expressing opinions on the placement of processing plants, the encouragement of certain aspects of the industry, such as curing of herring, and the discouragement of other activities such as the reduction fishery. For instance, Pacific Fisherman (1932) reports that in 1931, the plans for a Kodiak reduction plant were opposed by the Bureau of Fisheries and the building of the plant was delayed for over a year as a result.

An example is given in 1946 by Pacific Fisherman where the removal of the size limits on herring purse seines, and the quotas for all herring production areas were increased, apparently to provide an opportunity for Alaskan fishermen and processors to take advantage of post-war relief demands for food. In 1940, when Southeast Alaska was having serious problems with the herring stocks, the season for herring was reluctantly opened by the Fish and Wildlife Service, although the quota was so small that two of the three plants operating in the area decided not to enter the fishery. By 1941, Southeast Alaska had no herring curing sector. This development was happening, to an extent, in Kodiak, Prince William Sound, and Cook Inlet. By the late 1940s, curing in Alaska reached negligible proportions both because of poor stocks of large fish and poor market conditions. On the other hand, British Columbia's catch was phenomenal, exceeding 200,000 tons of herring (Pacific Fisherman 1949). By the mid 1950s, it was becoming clear that management by traditional methods of determining year class strengths within populations and setting quotas was not nearly as accurate as had been hoped at the outset of management history: herring apparently exhibited natural fluctuations that occurred as a result of factors other than catch.

The year of 1958 was a bitter disappointment for Kodiak and Prince William Sound. However, Southeast Alaska had a very good year. It was during this year that the Alaska Board of Fish and Game undertook the project to determine some of the causal relationships between herring abundance and physical factors (Pacific Fisherman 1959). In the early 1960s, the request of reduction processors to market a high quality of fish flour for U.S. consumption was denied by the Food and Drug Administration. FDA claimed that the idea of processing whole fish to flour was "repulsive" and substandard. The only other outlet for these goods produced by reduction processors was fast closing because of marketing and technological changes in other sectors of the economy.

By 1964, only two processors operated in Southeast Alaska and they, remarkably, were getting good prices for their oil and meal (Pacific Fisherman 1965). In 1965, a disappointing season occurred again. But there was still some reduction of herring in Zachar Bay on Kodiak Island by Washington Fish and Oyster Co., as a result of the processing of about 316,000 pounds of herring roe for export to Japan (Pacific Fisherman 1966).

Trade History

At the outset, the Alaska herring fishery was confronted with several problems that became worse as a result of changing U.S. trade policy with other nations. Hard salted herring was shipped from the United States to the orient, but the results were poor. The Alaskan trade target, however, was on the capture of the eastern market. This unfortunately, never occurred at any time during the Alaskan curing and canning industry's rugged history. One of the reasons for this trade difficulty was the low tariff on imported herring products from Great Britain, Newfoundland, Norway, and Iceland. An additional discouragement was that the allied powers during World Wars I and II, of which all the above countries were a part, were able to sell herring products in the United States for low or no tariff rates. The overall result was to introduce Alaskan herring processors to competitors who for hundreds of years had developed an efficient production and produced a consistent product quality and was closer to consumption points than Alaska. Despite these difficulties, the Kodiak/Aleutian area of Alaska managed to gain recognition, at least on the West Coast, for Scotch-cured herring. Southeast Alaska, in this respect, was not as lucky, having no plentiful supply of large herring on hand. Between bad herring packs brought about by herring with "red feed" problems and their overall small size, Southeast Alaska curing activities, limited from the start, by 1950 were negligible. The most chronic and unavoidable problem that Alaska herring processors faced were the costs of labor and transportation. Having to induce semi-skilled labor to come to Alaska to process herring boosted labor costs. The distance to the final market placed Alaska-cured herring in a bad light compared with European imports. Another less obvious reason for the decline were the sometimes protracted labor disputes that occurred among fishermen, packers, and plant workers.

As early as 1931, various oils, including herring were being experimented with for use in livestock food for finishing (Pacific Fisherman 1932). Research was in progress as early as 1935 in the detection and removal of the darker colored oils from herring oil (Pacific Fisherman 1936). These efforts were started because of the lower price that dark or "red" herring oils commanded on the markets due to their limited usefulness to the production of other items. The search for methods to clarify oil led to the invention of new techniques for rendering the oil, which eventually resulted in the invention of low heat reduction equipment.

Packaging of traditional products showed improvement at this time. At several points in history, beginning in 1904 when the Juneau Packing Company first produced canned sardines, some Alaska processors tried canning herring products. This followed the example of the processors in British Columbia who developed their canning industry, it seems, on the crest of two world wars. However, the Juneau Packing Company endeavor did not meet with much success. For example, in 1945, while British Columbia processors were experiencing the largest production of canned herring in the history of the territory (some 1,400,000 cases), Baranof Packing in Central Alaska was still involved in experimental canning of herring (Pacific Fisherman 1946). In 1938, New England Fish Company (NEFCO) experimented with cellophane wrapped kippers of herring, thereby enabling the buyer to see the product being bought without exposing it to air.

A number of other improvements occurred in the processing sector of the fishery, including grading/measuring machines and elevators introduced in 1926. Changes in harvesting efficiency of herring closely paralleled improvements evident in the rest of the fishing industry. Sails gave way to diesel power; cordage and netting materials and styles improved; electrical systems became part of fishing vessels; and, finally, radio communications advanced and the "echo sounder" was introduced.

This new invention, which became popular in the mid 1940s, was able to record not only depth, but also density and location of herring schools. This spelled the end of having to rely on signs on the surface of the water or use of the "wire" to determine the presence of a school. By 1947, echo sounders were used not only by most herring fishermen, but also by halibut and tuna fishermen.

The relation of the bait fishery development to the rest of the herring fishery was a strange one indeed. As the halibut fishery developed farther into the western reaches of Alaska, the salmon trolling fishery became more important, and finally, the crab fishery became the dominant source of demand for bait. However, these demands were being placed on those processors who were principally involved in reduction. In 1909, Canada refused sale of bait to American buyers (Bower 1920). This shutdown caused NEFCO to freeze bait which apparently filled the gap. However, a combination of erratic catches and limited bait centers for halibut fishermen kept the fishermen on edge. In roughly the same period of time, the reduction plant at Killisnoo again became embroiled in conflicts with those who believed that herring exploitation would diminish salmon stocks, and those desiring the services of Alaska processors as suppliers of bait herring.

The herring oil and reduction fishery escaped these difficult marketing predicaments until the late 1950s and early 1960s although they were subject to the vagaries of the herring population. It was then that South American countries, notably Peru, began producing oil and meal in proportions that completely overshadowed any fish meal production in the United States. Even before this, the oil market had been gradually slipping out of the hands of the herring reduction sector because of the switch from soap to detergents. The change to synthetic-based detergents lasted from the early 1930s to the late 1950s. During this time an attempt was made to find other uses for the oil in livestock production. However, when soybeans reduced the role of fish meal and oil as livestock feed, the reduction industry was finished.

In 1963, the Japanese in searching for a source of salmon roe found that Alaska had a potential for exporting herring also. This was the start of a new trade outlet for herring, and is its most valuable use today.

CHAPTER VIII

THE HERRING RESOURCE

Geographical Distribution and Biological Aspects

The Pacific herring (*Clupea harengus pallasi*) is, as its scientific name implies, a subspecies of the Atlantic herring (*Clupea harengus harengus*), and as such has nearly the same morphological characteristics. The exceptions are that, in general, the Pacific herring is smaller and has a larger and longer dorsal fin placed in a slightly anterior position relative to that of the Atlantic herring. However, the Pacific herring possesses behavioral characteristics that set them markedly apart from their cousins in the North Atlantic (Demel and Rutkowicz 1966; Kasahara 1961). The distribution of *C. harengus* may be circumpolar (Figure 18) with the Barents Sea being an area of some mixing with the Atlantic stocks (Demel and Rutkowicz 1966). Both subspecies have different races which may have slightly different morphology, and may also have different migration and homing patterns, times for spawning, locations for spawning, ages to maturity, longevity, and different growth rates, even in an area the size of Alaska. These differences within the species group itself make it difficult for the fisheries manager to determine the stock conditions by deriving equilibrium or maximum sustainable yield.

The spawning of herring appears to be temperature-related. However, different races spawn at a wide range of temperature.

Atlantic herring generally spawn in the warmer ocean water of the fall season. Pacific herring spawn in the colder water of spring. The further south one goes, the earlier in the year spawning begins. The Alaskan spawning season begins roughly in March and usually lasts well into June. There have been accounts, however, of spawning taking place in water temperatures below freezing (Kasahara 1961) to over 14°C. Pacific herring spawn shallow (15 to 20 meters); Atlantic herring spawn in the deep ocean, with some exceptions in areas of the Northwest Atlantic. Pacific herring may become accustomed to brackish or even fresh water; Atlantic herring usually do not, again with exceptions in some parts of northern Europe. Recruitment of spawners for Pacific herring may be as early as two years in British Columbia or as late as five years around Hokkaido and South Sakhalin (Kasahara 1961), with both areas occasionally recording recruits at the opposite extremes.

A north-south difference in growth rate is evident in both Pacific and Atlantic herring stocks. Since a fast growth rate contributes to an earlier maturity and southern races grow quickly with respect to northern races, the year class for spawning is generally younger in the south than in the north. Therefore, different studies that supply figures for potential yield or maximum sustainable yield for the world may conflict. Conflicts in information may be traceable to the great biological adaptability of herring races.

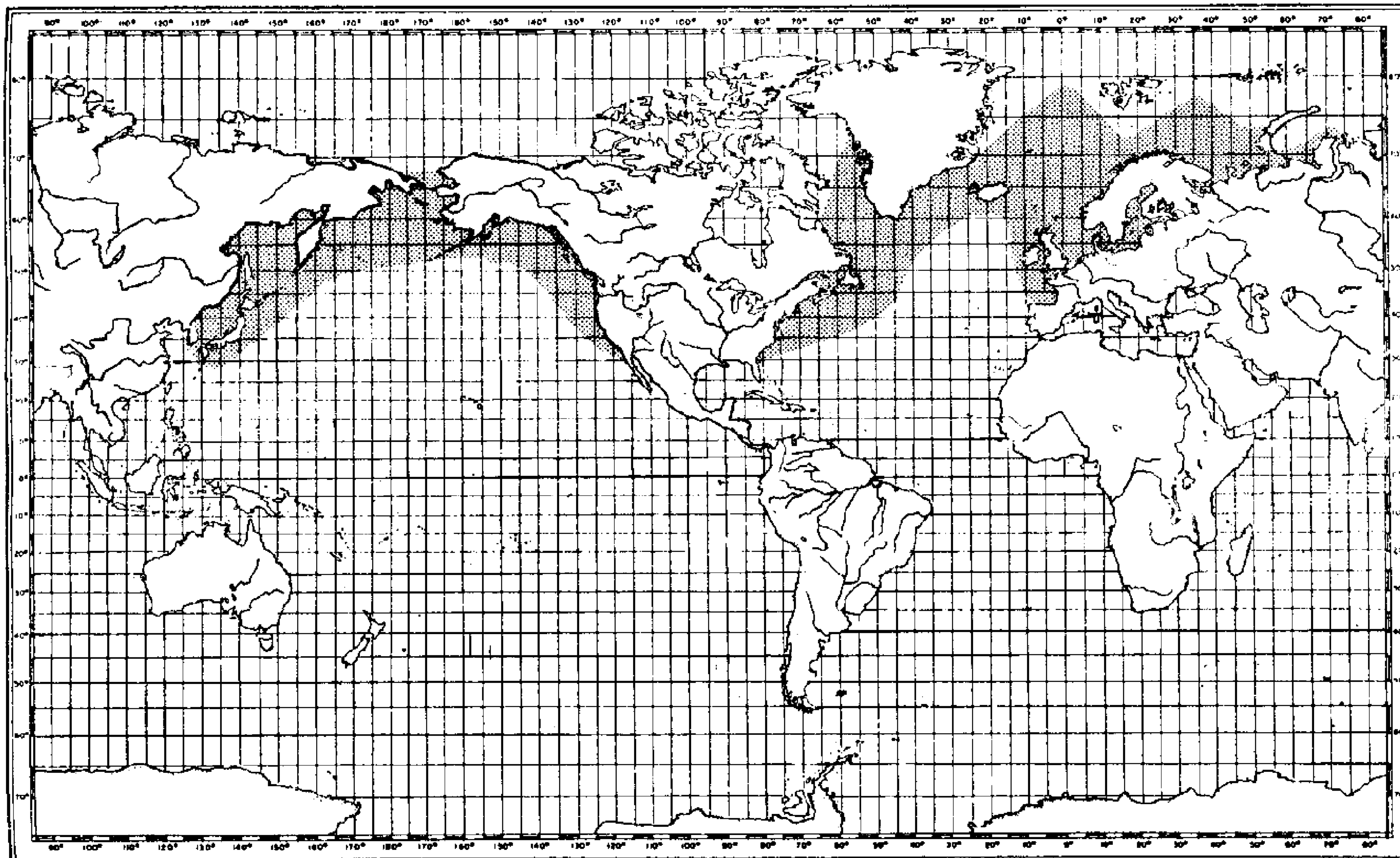

FIGURE 18. WORLD DISTRIBUTION OF HERRING (Clupea harengus sp.). After Demel and Rutkowicz (1966), Svetovidov (1953), and Gulland (1971).

Major World Stocks

The Atlantic

Some of the herring fisheries of the Atlantic, such as those found in the North Sea near the Scandinavian countries and the British Isles, have been exploited for well over 400 years. As a result, the fishery has experienced wide fluctuations in the stock from both fishing pressure and year class strength (Gulland 1971). Other stocks, such as the northwest Atlantic herring, have experienced greater exploitation in recent years due to pulse fishing by the USSR trawl fisheries of the late 1960s.

The International Commission of the North Atlantic Fisheries (ICNAF) was, until the spring of 1977, the primary data collection agency for the western part of the North Atlantic (Table 55). It is of note that the statistics between 1967 and 1972 show a phenomenal increase in total catch, attributable to the Russian expansion into this area.

Gulland (1971) estimated equilibrium yields for different areas of the northeast Atlantic. These are recorded at the bottom of Table 55 as MSY. This describes the range or magnitude of catch that could be expected from the statistical areas. Again, it does not appear that a classical yield-effort approach was used in arriving at these figures. The upper and lower bounds for the maximum sustainable yield (300,000 to 1,000,000 metric tons) cover a range that renders the estimate virtually useless. However, in view of the levels of fishing over this area prior to and after the years 1967 to 1972, it seems unlikely that, for instance, the equilibrium yield would approach one million metric tons. Alternatively, the case could be made that the pulse of heavy fishing from 1967 to 1972 has sent a considerable shock through the herring population and the lagged effects, if equilibrium is ever obtained, may bring the catch considerably below even Gulland's lower bounds of 300,000 metric tons.

The catch statistics of the International Council for the Exploration of the Sea (ICES) are much harder to interpret because of the long use of the herring stocks by many nations. However, a table showing the catch by major areas (Table 56) shows that the areas hardest hit in recent years have been the Barents Sea, the fishing grounds surrounding the Faeroe Islands, Kattegat and Skagerrak in the northern Baltic Sea, and the North Sea. Although the catch in the Atlantic constitutes the major source of herring in the world, the North Sea which has been one of the most prolific areas for herring, has faced a gradual decline. As early as 1971, an Organization for Economic Cooperation and Development (OCED) study by Norwegian marine biologists concluded that the herring stocks in the northeast Atlantic had declined from an estimated 14 million in 1955 to less than one million in 1970 (Bybee 1977). As a result, a temporary ban of the North Sea herring fishery was agreed to in May 1977. The situation as it stood then is summed up by the United States' European Economic Community (EEC) mission in Brussels:

TABLE 55

HERRING CATCH OF THE NORTHWEST ATLANTIC, BY AREA AS REPORTED BY ICNAF, WITH COMPARATIVE POTENTIAL YIELD ESTIMATES
(In Thousands of Metric Tons)

Year	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	ST	Non-Member Total	Total
1954	-	-	7	85	58	2	152	-	152
1955	-	-	5	82	-	2	89	-	89
1956	-	-	4	78	66	4	152	-	152
1957	-	-	8	91	73	-	172	-	172
1958	-	-	11	92	81	-	184	-	184
1959	-	-	4	102	48	-	154	-	154
1960	-	-	6	105	69	-	180	-	180
1961	-	-	4	81	94	-	179	-	179
1962	-	-	5	116	223	-	344	-	344
1963	-	-	6	112	167	1	286	-	286
1964	+	-	3	140	159	1	303	-	303
1965	+	-	8	181	74	2	265	-	265
1966	+	-	23	236	166	5	430	-	430
1967	-	-	79	261	250	5	595	-	595
1968	-	-	145	370	407	29	951	-	951
1969	-	-	145	422	260	53	880	88.3	968.3
1970	+	+	135	416	220	40	811	39.0	850
1971	+	+	118	311	276	42	747	-	747
1972	+	1	52	259	221	16	548	-	548
1973	+	+	17	233	221	14	485	-	485
1974	+	+	18	228	174	13	433	-	433
1975	+	1	23	241	178	5	448	-	448
1976	+	1	29	199	93	1	323	-	323
MSY	-	-	X10?	150-300?	150-300?	-			∿300-1000

Source: International Commission of the North Atlantic Fisheries Fisheries Bulletin; Gulland (1971).

TABLE 56

NOMINAL CATCHES OF HERRING: CATCH WITH ESTIMATES OF POTENTIAL YIELD BY AREA
(In Metric Tons)

YEAR	I	IIa	Va	Vb	IV	VI	VII	IIIb,c,d,	IIIa	TOTAL
1960	68,184	897,930	224,478	23,080	786,950	68,230	36,412	168,101	94,560	2,367,925
1961	99,162	551,213	461,584	8,333	689,778	51,943	56,312	175,844	121,091	2,216,070
1962	95,401	505,783	650,508	6,618	678,515	63,699	37,226	177,045	116,771	2,331,556
1963	93,153	622,969	507,703	23,060	805,301	53,949	29,543	214,852	159,988	2,510,518
1964	7,869	861,664	625,141	14,514	932,046	69,720	20,753	216,001	273,603	3,021,311
1965	123,041	1,045,845	624,040	4,391	1,230,315	66,385	23,385	214,916	238,923	3,571,241
1966	174,892	1,344,894	482,615	8,618	1,038,851	93,147	38,306	232,709	152,449	3,566,481
1967	381,036	1,167,032	118,014	27,016	819,324	103,074	40,166	267,224	244,698	3,167,584
1968	367,012	282,685	30,775	6,019	850,127	100,323	41,525	315,652	288,987	2,283,105
1969	15,230	46,986	24,103	5,646	725,381	123,593	68,463	276,102	113,086	1,398,590
1970	925	61,522	16,445	2,904	748,750	157,721	72,130	312,961	85,675	1,459,033
1971	131	22,215	11,836	2,662	644,385	226,310	69,185	335,505	90,274	1,402,503
1972	7	13,129	312	-	604,808	197,212	91,304	345,687	106,822	1,359,281
1973	27	6,989	254	9,073	599,131	244,945	78,948	404,172	140,851	1,484,390
1974	2	7,581	1,287	7,859	326,600	203,757	73,297	407,081	100,676	1,128,140
1975	1,100	3,911	13,280	18	295,307	142,397	83,658	414,757	120,987	1,075,415
1976	-	655	17,168	2,486	162,531	111,806	67,302	393,488	92,211	847,647
1977P	5,648	12,282	28,925	86	41,273[b]	47,615	30,328[a]	434,990	37,587[c]	638,734

Source: International Council for Exploration of the Sea (1978)

Note: I= Barents Sea; IIa= Norwegian Sea; Va= Iceland Grounds; Vb= Faeroes Grounds; IV= NW Coast of Scotland-North Ireland, Rockall; VII= VIIa+f, b+c, g-k, d-e; IIIb,c,d= Baltic, the Sound and Belt Sea; IIIa= Kattegat and Skagerrak. Equilibrium yield estimates for these areas are as follows: I, IIA, Va, Vb-1.5 million MT; IIIs and IV-one million MT; VI and VII-200,000 MT: IIIb,c,d-250,000 MT; total -3.0 million MT (Gulland, 1971)

P......Preliminary
a......Incomplete data
b......Including divisions VIId and e
c......Only for Skagerrak

> In recent EEC discussions, the European Commissions and the U. K. have stood most consistently for a permanent ban against the herring fishery, and Denmark (in opposition to the ban because of heavy investment in reduction plants) has found itself increasingly isolated on this issue. The Federal Republic of Germany and the Netherlands, both importing large quantities of herring, have been reluctant to oppose the Danish point of view. It appears that, either as a result of a permanent ban imposed this summer or through repeated extensions of temporary bans, the North Sea herring fishery may be closed for the remainder of 1977.

As of this writing, (April 1980) the ban is still in effect, with the exceptions of the Danish by-catch allowance of ten percent of the Sprat catch and allowances of herrings for the "Maatjes" festival in the Netherlands.

A number of countries participate in the Atlantic herring fishery, the most notable being Canada, the USSR, Denmark, Sweden, Poland, Scotland and Finland (Table 57). However, for the East Coast, at least, the U.S. role in the herring fishery is not major. In 1976, the U.S. East Coast fishery for herring constituted 15.5 percent of the catch in the North Atlantic, according to International Council of North Atlantic Fisheries (ICNAF) statistics.

The Pacific

Excerpts from Gulland's discussion on the Northwest Pacific herring stocks describe the status of the fishery in this area as of 1971:

> Herring was once the largest stock in Hokkaido.[1] Around 1900, about 750,000 tons were caught along the coasts of Hokkaido, but since then have generally begun to decrease until the early 1950s; however, occassional occurrences of a dominant class at intervals of three to six years supported the fisheries for the next few years and the catch was maintained at a level of 200,000 to 300,000 tons (Ishida 1952; Motoda and Hirano 1963; Ayushin 1963). The present fisheries in Hokkaido have almost collapsed with the last dominant year class in 1939. Meanwhile, it is observed their spawning grounds have shifted northward and gradually diminished (Hanamura 1963).
>
> The same is generally true for herring stocks in the Sea of Japan along the coasts of North Korea, Peter the Great Bay and Primor'e (Hirano 1961; Motoda and Hirano 1963). The herring abundance has entirely shifted to the northern coast of the Sea of Okhotsk.... Spawning success seems to be related to peculiar hydrographical conditions in the northern

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[1]Other sources (Kasahara 1961) cite the Hokkaido stock as potentially one of the largest in the Northwest Pacific.

TABLE 57

YEARLY CATCH BY COUNTRY OF ATLANTIC HERRING (CLUPEA HARENGUS HARENGUS)[1]

(In Thousands of Metric Tons)

Year	Canada	US	Denmark	Finland	France	FR of Germany	Iceland	Netherlands
1938	82.5	10.1	14.3	15.5	76.0	244.3	155.9	121.3
1948	154.3	88.0	26.0	16.0	78.1	168.7	150.1	169.6
1958	105.7	84.1	297.1	29.9	40.4	252.2	107.3	129.9
1961	87.7	26.4	253.2	35.5	38.1	129.2	325.9	133.3
1962	111.8	71.9	260.8	31.9	30.3	137.0	478.1	91.6
1963	114.6	70.2	290.8	49.2	34.8	127.2	396.5	136.4
1964	141.8	28.3	359.9	35.7	36.4	123.2	544.4	122.5
1965	183.9	34.4	344.9	45.8	26.4	116.2	762.9	87.9
1966	249.4	32.8	277.9	42.1	22.4	141.8	770.7	74.7
1967	345.2	31.7	325.4	44.1	20.6	124.1	461.5	57.6
1968	522.8	43.0	418.5	61.2	22.8	143.1	141.7	41.5
1969	487.1	31.4	318.4	56.7	27.1	178.9	56.9	48.9
1970	478.9	30.3	254.0	51.9	24.4	169.2	51.4	58.4
1971	419.3	34.5	332.3	58.7	23.5	85.5	61.4	53.4
1972	304.1	40.2	357.9	54.5	29.9	53.6	41.7	56.3
1973	226.3	26.2	383.0	68.6	33.6	71.0	43.4	73.3
1974	225.6	32.6	176.9	73.8	25.3	59.1	40.5	59.3
1975	241.9	36.2	216.7	70.7	30.5	51.9	33.4	71.0
1976	225.5	50.1	107.3	76.8	21.7	22.8	30.0	57.1

TABLE 57 (Continued)

Year	Norway	Poland	Sweden	England Wales	Scotland	USSR	% of World Catch of All Herring	% of Total World Catch of Clupeids
1938	649.9	9.9	67.8	131.4	142.3	16.1	99.13	36.11
1948	956.6	5.3	95.7	119.8	148.0	27.1	98.67	46.68
1958	607.6	71.4	118.4	25.9	83.8	496.1	97.41	33.47
1961	545.8	95.8	150.9	18.9	69.1	460.1	96.61	18.88
1962	559.0	78.7	160.0	13.8	75.5	566.5	97.23	18.15
1963	510.0	101.5	193.1	24.4	79.6	648.0	96.74	18.58
1964	735.4	113.2	182.9	17.9	80.2	783.0	96.83	17.80
1965	1078.8	125.6	263.8	15.3	82.7	704.0	96.77	22.96
1966	1185.9	117.1	216.1	13.0	101.5	706.5	96.67	21.21
1967	1214.9	108.8	237.8	12.6	88.2	657.0	96.20	19.03
1968	704.8	132.0	217.4	9.8	83.8	567.0	94.83	15.20
1969	191.1	99.6	185.7	11.0	111.9	204.3	83.91	11.09
1970	285.1	128.2	173.6	14.5	126.7	133.6	85.65	9.26
1971	236.5	136.2	127.9	9.9	132.9	110.3	85.49	9.38
1972	156.0	100.5	120.0	7.7	137.9	72.3	82.46	11.32
1973	146.2	114.7	123.6	5.7	145.4	251.9	86.48	15.90
1974	76.1	112.6	115.3	11.1	129.4	212.3	86.25	10.34
1975	40.2	117.5	100.6	8.5	98.5	205.5	86.98	9.72
1976	36.5	85.0	92.2	12.2	73.1	155.7	88.76	6.93

Source: FAO: Yearbook of Fishery Statistics.

[1]Some totals have been estimated by FAO in the absence of reliable data from member countries.

Sea of Okhotsk; that is, a narrow band of pack ice along the coast begins to melt earlier than offshore, although the timing closely depends on the climate to provide favorable conditions to phytoplankton development (Ayushin 1947; Kaganovich and Polytov 1950).

The decline in Japanese domestic catch was one of the reasons that in the early 1960s Japan started searching in other countries for a supply of fish products and a resource to fish. The feasibility of importing herring roe products from Alaska and Canada was almost an incidental idea, as the Japanese were originally interested in salmon roe products. However, the Japanese, and followed closely by the Soviets, made the initial exploration of the western Bering Sea herring resource. By the mid 1960s, the stocks there had been pushed to economic extinction. The term "pulse fishing" has been applied to this activity where stocks of one species are fished to economic extinction, though not necessarily to physical extinction. Until the Fisheries Conservation and Management Act of 1976, the herring resources of the eastern Bering Sea were becoming another target for directed foreign fishing. This fishery is now controlled by area/time closures and quotas. Tables 58 and 59 show the development of the Japanese and USSR fisheries in the Eastern Bering Sea and Aleutian Islands areas and the Bering Sea excluding the Aleutian Islands region. It is interesting to note that, in Table 59, the area west of 175° west longitude shows that the Japanese gillnet fishery for herring no longer existed after 1969. It looks as if this herring stock was pushed to extinction.

Other interesting developments can be followed from Table 60, compiled from FAO statistics. Canada's drop in catch in the Pacific Ocean definitely attests to difficult times in the late 1960s which led ultimately to a moritorium on herring catch in 1968 and 1969. This may be seen more clearly in the herring landings as recorded by Canada's Department of Environment, Fisheries and Marine Service (Table 61).

The United States catch as shown by FAO statistics corresponds to the demise of the herring reduction fishery and the subsequent revitalization of the industry as a result of the new markets for herring roe in Japan. Other important developments were the increase in Korea's activities in the Bering Sea, and the comparatively recent entry of the German Democratic Republic and Poland in the North Pacific herring fisheries.

Despite the obvious importance of the herring stocks to the major participants in the North Pacific fisheries, the catch for all countries is small when compared to the world catch of Clupeids, or herring-like fishes. This gives an indication of why herring reduction industry in Alaska, for example, is virtually nonexistent today. It appears that, for the quantity of herring caught, the costs of production, relative to those of other producing areas in the United States and the world, prohibited the contribution of the industry.

TABLE 58

HERRING CATCHES BY THE USSR AND JAPAN
FROM THE EASTERN BERING SEA AND ALEUTIAN ISLANDS AREA
(In Metric Tons)

Year	U.S.S.R.	Japan	Year	U.S.S.R.	Japan
1959	10,000	---	1968	22,000	45,000
1960	10,000	---	1969	94,000	36,000
1961	80,000	74,000	1970	117,000	28,000
1962	150,000	10,000	1971	23,000	23,000
1963	150,000	32,000	1972	54,000	6,000
1964	175,000	43,000	1973	34,000	2,000
1965	10,000	36,000	1974	20,000	6,000
1966	5,000	28,000	1975	14,000	2,000
1967	---	33,000	1976	17,000	15,000

Sources: Chitwood (1969); U.S. Department of Commerce, National Marine Fisheries Service (1977).

TABLE 59

CATCH OF HERRING BY JAPANESE AND SOVIET TRAWLERS EAST OF 180° IN THE BERING SEA AND JAPANESE GILLNET VESSELS WEST AND EAST OF 175° WEST IN THE BERING SEA, EXCLUDING THE ALEUTIAN REGION, 1964 TO 1975
(In Metric Tons)

Fishing Year (July-June)	Trawl Fisheries Japan	Trawl Fisheries USSR	Trawl Fisheries Total	Japanese Gillnet Fishery Calendar Year	Japanese Gillnet Fishery West of 175°W	Japanese Gillnet Fishery East of 175°W	Japanese Gillnet Fishery Total
1964-65	1,362	[1]	[2]	1964	41,597	-	41,597
1965-66	3,117	[1]	[2]	1965	34,659	-	34,659
1966-67	2,831	[1]	[2]	1966	24,118	-	24,118
1967-68	9,486	9,800	19,286	1967	30,167	-	30,167
1968-69	50,857	75,379	126,236	1968	5,183	818	6,001
1969-70	23,901	92,228	116,129	1969	680	1,949	2,629
1970-71	24,236	60,126	84,362	1970	-	1,585	1,585
1971-72	13,143	67,547	80,690	1971	-	4,603	4,603
1972-73	346	39,999	40,345	1972	-	472	472
1973-74	219	16,810	17,029	1973	-	1,878	1,878
1974-75	2,685	19,342	22,027	1974	-	3,337	3,337
-	-	-	-	1975	-	734	734
				1976	-	2,461	2,461

Sources: Japanese Fisheries: INPFC Docs. 833, 879, 1021, 1102, 1275, 1339, 1423, 1525, 1599, 1769, 1692, 1802, 1804, 1806, and 1813, Forrester (1978).

USSR Fishery: 1967 to 1975: Furnished by the USSR under provisions of U.S.-USSR fisheries agreements.

[1]Not available.
[2]Incomplete.

TABLE 60

YEARLY CATCH BY COUNTRY OF PACIFIC HERRING (CLUPEA HARENGUS PALLASII)[1]

(In Thousands of Metric Tons)

Year	Canada	U.S.	Japan	Korea Rep of	Philippines	USSR	Germany Dem Rep.	Poland	% of Total World Clupeid Catch
1938	60.3	105.2	43.5	---	---	41.2			5.93
1948	189.1	81.5	192.0	0.1	---	116.6			12.39
1958	183.8	45.1	38.3	0.1	---	332.6			8.27
1961	203.4	24.7	97.5	0.4	6.8	272.8			4.83
1962	202.0	18.9	30.8	0.3	2.5	320.5			3.91
1963	259.6	17.6	46.2	Ø	5.9	393.3			4.84
1964	229.2	22.6	62.9	Ø	8.4	460.5			4.22
1965	201.4	15.6	50.2	Ø		331.2			3.55
1966	139.6	10.9	48.6	---		323.3			2.78
1967	53.0	8.3	63.7	---		342.2			2.38
1968	2.9	6.8	67.9	1.2		445.5			2.56
1969	2.0	9.8	85.2	0.9		507.0			3.34
1970	3.9	9.9	97.4	0.7		467.7			2.71
1971	10.0	5.3	150.8	6.7		310.6			2.49
1972	39.0	6.1	58.0	6.7		325.0			3.21
1973	55.6	20.3	79.8	4.5		379.9		.1	4.77
1974	44.7	22.0	72.8	0.4		304.9		---	3.20
1975	59.6	17.9	64.5	2.4		327.9	15.4	1.4	3.59
1976	81.1	18.3	65.2	1.0		209.0	.5	---	2.49

Source: FAO; Yearbook of Fishery Statistics.

[1]These figures represent the total catch of Pacific herring as recorded by FAO yearbooks from 1963 to 1976. Years 1973 to 1976 for some countries may have been estimated by FAO.

TABLE 61

BRITISH COLUMBIA HERRING LANDINGS, 1960 TO 1976
(In Thousands of Pounds)

1960	187,676	1970	8,521
1961	448,433	1971	22,083
1962	445,275	1972	86,025
1963	572,194	1973	122,630
1964	505,287	1974	97,728
1965	444,061	1975	131,480
1966	307,653	1976	178,804
1967	116,741	1977	209,437
1968	6,373	1978	179,454
1969	4,415		

Source: Government of Canada, Fisheries and Oceans. British Columbia Catch Statistics: Annual Summary.

Another important observation is the absence of any data from Mainland China on catch or production of any fish, despite repeated efforts by FAO to obtain this information (Kravanja 1978). It is known, however, that Communist China had been a major supplier of herring products, roe especially, to Japan prior to 1972, after which Canada took the export lead. Although in recent years, China has not been a strong influence on roe markets in Japan, no one is sure if it is because of political reasons or because of poor herring seasons (Frazer 1978). However, recent developments in relations with China and Japan suggest that China is gearing up to open trade channels. China also appears to have been making overtures to Japanese buyers of herring roe (Minato 1978). It is possible, therefore, that Alaskan and Canadian processors and fishermen will find considerable competition from both China and the USSR in not only herring roe but also underutilized species, since both countries have recently liberalized their trade relations with Japan through agreements (Kitano 1978).

Alaska's Herring Fishery; Relations with British Columbia Fisheries

The historical catch statistics for the herring fishery in Alaska and British Columbia have been well documented by Rounsefell (1930 and 1931); Skud et al. (1960); Blankenbeckler (1976 and 1978); Moberly and Thorne (1974); Alaska Department of Fish and Game statistical leaflets; Fisheries and Marine Service, British Columbia; and Pacific Fisherman. No attempt is made to expand on these works. Alaska's herring catch since 1960 by major statistical area as reported by Alaska Department of Fish and Game, is shown in Table 62 for reference.

Alaska's catch, in comparison with other states involved with the herring fishery, is one of relative prominence. However, Maine has been the high producer throughout the entire range of the data shown in Table 63. Alaska's share of the total U.S. catch hit an all-time low of 7.6 percent in 1968. In 1977, Alaska's catch had increased to 21.9 percent. Maine, although the high producer of herring because of the "sardine" canning industry there, has had to transship raw products from Canada on occasion in order to maintain full production. This is partly the reason that Canada is a heavy exporter of fresh/frozen herring to the United States.

The British Columbia catch statistics (Table 61) reveal that the only time that fishery ever came close to having as small a catch as Alaska was during the moratorium on herring fishing in 1968, because of stock depletion. British Columbia has traditionally been more active than Alaska in exploiting its herring resource. Canneries for herring products are common and a substantial amount of meal is still exported to the United States. In the mid 1960s, the Canadian fisheries geared up to supply Japan with herring roe products. By 1972, Canada was the leading seller of herring roe to Japan. Their influence on the Japanese roe market was so vast that the Canadian fishing season, which starts somewhat earlier, sets the mood for herring roe sales in Alaska.

Alaska's herring fisheries, when placed in a world perspective, play a minor role compared to Europe and Canada. The unknown potential of

TABLE 62

ALASKA HERRING CATCH AND VALUE, 1960 TO 1977
(In Pounds)

Year	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Lbs	Value	Lbs	Value	Lbs	Value	Lbs	Value
1960	77,812,840	832,677	99,925	1,998	---	---	77,912,765	834,675
1961	49,419,000	558,330	46,300	690	---	---	49,465,300	559,020
1962	33,874,800	379,300	1,610	20	---	---	33,876,410	379,320
1963	31,213,710	468,200	2,520	40	---	---	31,216,230	468,240
1964	46,698,420	700,480	1,205,540	18,080	---	---	47,903,960	718,560
1965	24,318,555	340,460	1,317,651	20,030	---	---	25,636,206	360,490
1966	13,680,012	205,200	5,551,833	83,277	23,844	358	19,255,689	288,835
1967	6,050,500	90,758	5,177,160	77,657	268,902	4,034	11,496,562	172,449
1968	3,632,608	36,326	4,316,107	43,161	177,625	1,776	8,126,340	81,263
1969	7,365,785	132,583	5,671,065	113,461	94,481	11,338	13,131,331	257,382
1970	6,649,676	147,848	705,016	15,100	63,331	1,267	7,418,023	164,215
1971	5,983,333	111,626	4,134,151	157,824	----	----	10,117,484	269,450
1972	9,949,739	336,034	4,091,930	81,838	8,734	175	14,050,403	418,047
1973	15,900,935	1,164,957	18,902,775	1,494,874	66,743	1,064	34,870,453	2,660,895
1974	18,895,414	2,319,175	19,885,604	1,808,468	80,837	2,425	38,861,855	4,130,068
1975	14,981,436	602,147	20,482,758	1,267,504	111,185	4,447	35,575,379	1,874,099
1976	17,774,653	N/A	14,864,433	N/A	9,148	N/A	32,648,234	N/A
1977	13,884,260	N/A	11,039,700	N/A	6,305,600	N/A	31,229,500	N/A

Source: Alaska Department of Fish and Game Catch and Production Statistics, various years.

TABLE 63

U.S. LANDINGS OF CLUPEA HARENGUS SPECIES
(In Thousands of Pounds)

Year	Maine	N. Hampshire	Mass.	Rhode Island	Conn.	New York	New Jersey	Maryland
1960	152,327	---	1,960	250	130	197	324	4
1961	54,463	---	3,122	188	83	164	212	7
1962	156,699	---	1,331	167	58	63	206	12
1963	152,317	---	1,835	312	31	87	151[1]	8
1964	60,866	---	2,051	259	26	155	313[2]	13
1965	70,180	---	4,443	380	11	277	257[3]	8
1966	58,299	---	6,591	602	11	6,407	305	9
1967	64,600	---	3,560	396	1	147	52	5
1968	69,703	---	21,722	444	---	97	218	9
1969	54,214	---	9,882	4,506	---	133	370	--
1970	36,593	---	27,446	2,219	4	62	406	1
1971	28,572	---	43,354	2,888	3	16	85	1
1972	44,690	---	37,849	5,064	1	26	202	3
1973	37,229	---	10,757	9,342	---	21	114	15
1974	47,398	---	17,603	6,402	14	16	347	34
1975	38,247	---	32,153	8,954	---	124	220	31
1976	70,233	---	39,737	393	---	26	119	6
1977	73,050	---	37,727	646	---	17	73	--

[1] Includes a catch by Delaware of 11,000 pounds.
[2] Includes a catch by Delaware of 7,000 pounds.
[3] Includes a catch by Delaware of 5,000 pounds.

TABLE 63 (Continued)

Year	Virginia	Washington	Oregon	California	Alaska	Alaska % of Total U.S. Landings	Total
1960	2	4,104	2	1,801	77,913	32.60	239,014
1961	4	3,607	18	1,401	49,465	43.88	112,734
1962	----	6,372	16	1,306	33,876	16.93	200,106
1963	11	6,972	16	630	31,216	16.13	193,586
1964	58	3,960	33	349	47,904	41.30	115,987
1965	194	8,347	44	516	25,636	23.24	110,293
1966	75	4,515	94	242	19,256	19.97	96,406
1967	1,098	6,447	83	272	11,497	13.04	88,158
1968	42	6,448	41	358	8,126	7.58	107,208
1969	56	8,297	84	170	13,131	14.45	90,843
1970	10	4,418	48	316	17,036	19.24	88,559
1971	2,450	3,787	25	241	10,119	11.05	91,541
1972	696	3,452	29	125	15,302	14.24	107,439
1973	383	6,901	42	2,820	34,871	34.04	102,453
1974	58	12,139	58	5,260	38,862	30.32	128,191
1975	6	13,141	71	2,434	35,575	27.16	130,996
1976	.236	N/A	78	4,818	32,648	22.05	148,058
1977	.120	N/A	55	N/A	31,230	21.87	142,798

Source: NMFS Current Fishery Statistics, Fisheries of the United States annual summaries.

China and the USSR to supply roe markets in Japan places the present fishery in a tenuous position. Alaska's resource is also domestically used, but herring meal and oil for livestock finishing is subject to substitution effects with other fish meals. Bait sales are local and tied to a smaller consumer base, with the exception of isolated fillet sales that are indirectly routed to the U.S. via Europe. Most of the U.S.'s herring specialty foods are imported or from the East Coast. Alaska's catch of herring, compared to the other states in the union, is substantial, and compares favorably with Maine, the leading U.S. producer. The Alaskan bait herring fishery, for the present, is an indispensable industry to other local fisheries in Alaska, such as halibut and crab.

Methods Used for Measuring the Resource Abundance

In fish populations which have relatively short life spans and are subject to a number of adverse physical forces, the theoretical fisheries concepts that revolve around equilibrium relationships between the fishing effort and stock size become less distinct. In this situation, the time it takes for fisheries managers to put together a viable plan for adjusting the activities of the fishing fleet is slow compared with the rise and fall in abundance of different year classes of fish entering the fishery. The herring fishery, therefore, has been regulated by quotas based on estimates of abundance of the recruiting year class. There is an advantage in determining the quotas this way because the success of a season can be predicted two or three years prior to the actual season, based on abundance of spawn and presence of juveniles. Numerous works along this line have been advanced. The earliest work in outlining these parameters of herring populations in Alaska was by Rounsefell (1930). A short discussion of the method of establishing catch quotas by year class strengths in Southeast Alaska was given by Kolloen (1947). Herring stock assessment work by using these techniques has also been explored in British Columbia by Tester (1955), and Hourston (1958, 1959).

However, relating these concepts to the success of fishermen has historically been hard to coincide. That is, even with a correct interpretation of year class strength, there have been cases of unanticipated failures in the herring fishery, which must be attributable in the final analysis to the herring simply not being available to the fishermen during the season. This problem was outlined by Blankenbeckler (1976) and earlier authors in discussions of factors that affect herring stock abundance. It follows that the establishment of a quota must be based both on expected resource abundance and the actual presence of the fish.

Attempts have been made by the Alaska Department of Fish and Game since 1969 to augment their herring stock assessment work with hydroacoustical estimation of biomass prior to the herring season (Blankenbeckler 1978). Herring stock assessment by hydroacoustical techniques are made for the spring roe and winter herring fishery. The biomass, for a management area, is estimated and the quota is derived from this estimate (from 10 to 20 percent for the bait, food, and roe herring fishery in Southeast Alaska). It is apparent that this method of establishing quotas is not the same as using a classical yield-in-equilibrium relationship. Rather, it is an effort to determine in a short time frame what an acceptable catch level should be to diminish the possibility of a long-term disequilibrium in the fishery. This method has not gone unchallenged by some members of the industry who assert that the quotas derived are based on what they feel to be a downward bias in the sampling method. Indeed, two major faults may be found with the hydroacoustical system:

1. Surveyors, even with the best of intentions, may behave differently from fishermen and may, in fact, underestimate biomass and therefore the quota because of methods and equipment used.

2. Hydroacoustical data cannot differentiate herring populations as to size or age. These parameters must still be obtained through direct sampling. Because of the daily vertical migration of herring, hydroacoustical survey functions only during the evenings and early mornings, when herring are "on their way up" or "on their way down."

Aircraft are also being used to estimate herring abundance in the Bristol Bay-Bering Sea areas. The method employed is simply to estimate the biomass based on the number and size of the schools spotted from the air, and then adjust these estimates down by some fixed factor to account for capelin accidentally spotted as herring.

Other variations of herring stock assessment include attempts to predict strength of year classes through oceanographic changes (Ramey and Wickett 1973). These "strength predicting equations", like other prediction methods, have their good and bad points. For very local areas and for a well-defined population, one may develop a reasonably good predictive model of the abundance one could expect three to four years hence. However, statistical work based on prior collections of data falls victim to incomplete or incorrect forms of information. This would tend to diminish the predictive power of the model.

Summary

Herring possess biological features that, when considered in their entirety, set them apart from almost all other fisheries:

1. They are highly adaptable, occur in practically all coastal waters of the northern hemisphere, and may be circumpolar in distribution.

2. Herring are pelagic and a schooling fish, so much so that they seem to form tribes or races within the species. These tribes may have different morphological or behavioral characteristics that isolate them from other members of the same species.

3. The occurrence of herring is sporadic. There is no place that can be expected to consistently produce herring yearly.

4. They have a very high fecundity per average-sized female (about 20,000 eggs/female) and an extremely high mortality in larval life (about 99 percent) which is thought to be related to oceanographic conditions that cannot, as of this writing, be substantiated statistically.

5. Herring are relatively short-lived compared to other exploited species, notably halibut. Their normal life span is eight to nine years, although in some cases up to 12 years. They become sexually mature from two to three years, although in some areas of the Pacific they mature from four to five years, depending on race.

Because of these biological properties, environmental impingements on the resource manifest themselves quickly as "strong" or "weak" year classes--the year class being the survivorship to the fishery of spawning efforts, of two to five biological years prior to the present. In view of all of these features of the population, statistical sampling methods and classical population biology become difficult to deal with and statistical difficulties should be addressed when interpreting herring stock or year class strengths estimates.

CHAPTER IX

HARVESTING AND PROCESSING OF HERRING

Introduction

Herring used to be primarily a fish for reduction, but is now a highly prized food fish. Its flesh is again being used by some companies for production of specialty foods. The roe, or eggs, are highly prized by the Japanese. These changes in uses of the fish have brought both opportunity for fishermen and political and economic conflict. Harvesting technology and seasons for fishing have changed since the early 1960s to accommodate harvesting of the spring roe herring.

Harvesting Technology

Overview

The time, method of harvest, and the auxiliary equipment used in the herring fishery depend on the restrictions placed on the entry and harvest technology by the State of Alaska. State laws have also played a part in altering both the style of fishing and, to a large extent, the behavior of fishermen.

Catching methods are based on the herring's seasonal migration and daily vertical movements. The different methods that have been commonly used have been power assisted purse seines, hand-hauled beach seines, hand-hauled purse seines operated from two small boats, set gillnets, drift gillnets, trawls and empoundments. Within each classification there are, of course, a number of ways these gear types are constructed, set, and hauled. In addition, the herring roe on kelp fishery uses a number of hand tools for harvest.

State regulations that restrict seasons and gear type (and the Limited Entry law) set the pace of fishing for both fishermen and processors in all fisheries and for herring in particular. The regulations and quotas, if projected with a good knowledge of the resource, could be used by processors and fishermen for long-range planning of a season. The gear used, especially gillnet of both the set and drift variety, overlap the salmon fishery and as a result special considerations are given to these problems by enforcing closures in the herring fishery where closed seasons occur in the salmon fishery. The relatively recent development of the roe on kelp fishery and the herring roe fishery has introduced harvest techniques which have had to be regulated in consideration of other herring fisheries. In the season of 1977, rakes were prohibited from use in Prince William Sound. The herring roe on kelp fishery could be characterized by a large number of part time fishermen. However, with the purse seine, set gillnet, and drift gillnet fishermen, the fishing is serious, with usually a large investment in boat and gear, short hectic seasons, and high risk of poor take. In some areas of Southeast Alaska, for example, seasons are measured in terms of hours rather than days. On the other hand, fisheries of the

Bering Sea and other points west of Cook Inlet have a longer season for both sac roe and bait herring. The basic types of gear, despite all of these changes brought on Japanese demand, are refinements on old concepts rather than radical new designs.

Types of Gear

The Purse Seine - This most versatile piece of fishing gear (Figure 19) is also one of the most difficult to describe, owing to the tremendous variations in size, depth, and application. In general, however, its use is restricted to large bodies of water. The original purse seine appeared on the East Coast in 1826 (Browning 1974). Some of the precursors to the modern seine in Alaska include the Norwegian seine and the beach seine. Variations include the use of drum (illegal in Alaska) or power block net retrieval methods, with the net being set from the stern, side or bow; the use of a single boat and skiff; or of two vessels. The history and application of the net to different fisheries seem endless and, since the early 1950s when the power block was first invented by Mario Puretic, the resulting developments and use of purse seines for a number of different fish species has approached multinational proportions. The purse seine has been the subject of some fairly sophisticated research by the Scandinavian countries and the USSR as well as the tuna fishery of the West Coast of the United States.

However, purse seining in Alaska for herring follows the same basic principle as salmon purse seining. The methods and locations for seining are in some cases so much alike for both salmon and herring that Alaska has adopted laws to restrict the use of purse seines for herring in areas and times closed to salmon fishing.

The parts of a herring purse seine consist of the bunt and brest, or the few fathoms at the bitter end, the netting, the leadline and cork line, and the purse line. The purse line is found below the leadline and runs through a series of rings that are either solid or are built with a breakaway sidewall (Figure 19).

Location of a herring school is the first step in purse seining. This may be done with the help of airplanes to spot schools, or by careful sonar work. When a school is found, the depth of the school must be determined, and if the school is too deep, a decision may be made to wait until it rises to or near the surface.

Most often setting a net for purse seining is done from two boats, the seiner and a skiff. The seiner holds the net and power block. The skiff's main function is to encircle the herring school. The net is set, usually, with two boats. The seiner usually holds the net and the power block. The skiff, the other half of the team, may be involved in a number of operations throughout the setting, pursing, and net retrieval, although major function is usually to perform the encircling of the herring with the net. Variations in the setting strategy depend on the current direction and perceived movement of the fish. After the purse line is drawn, the rings are hoisted on deck and assembled so that one end of the net is passed through the power block. The net, on the

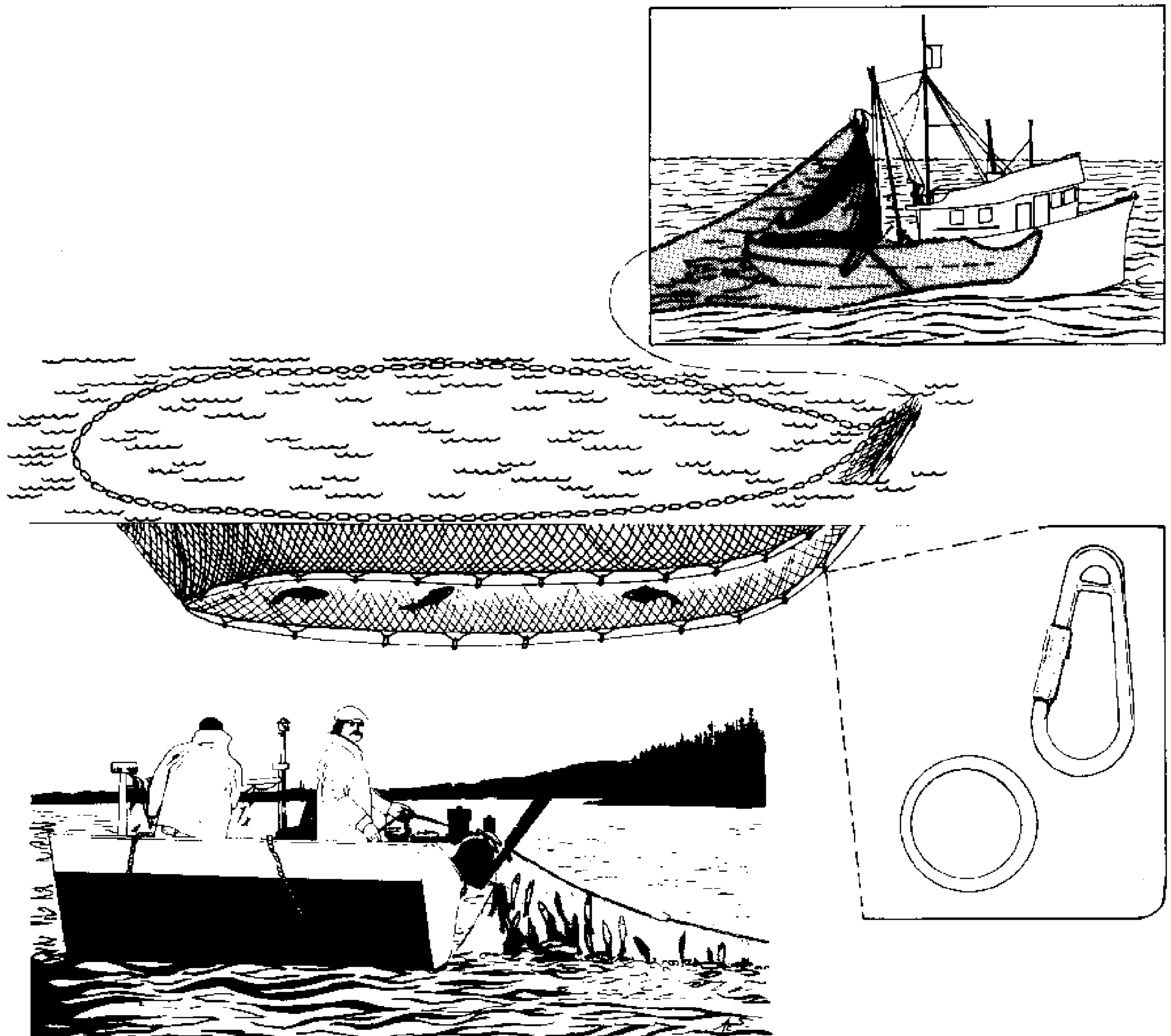


FIGURE 19. TWO GEAR TYPES USED IN THE HERRING FISHERY: PURSE SEINE SYSTEM; HERRING GILLNET.

other side of the block, is arranged for the next set, with the floats on one side of the boat stern and the lead line on the other side.

The Gillnet - This type of net is fished either with both ends secured (a set gillnet) or drifted behind a boat (a drift gillnet). Both types as used in the herring fishery rely on the habit herring have of rising to the surface during the evening. The gillnet is usually fished shallow in a constricted area like a fiord.

Although Alaska limits the length of both types of nets, the Japanese and Europeans use a larger form of drift gillnet that may be miles long (Hodgson 1957; Browning 1974). The fixed or set net is usually placed perpendicular to the shore with the necessary anchoring to fix its position. The set gillnet fishery was first used in the Southeast Alaska roe fishery in 1976. The vessel requirements are not as demanding for this type of fishing, and usually consist of a skiff or similar boat, built more for accommodating the catch rather than for seaworthiness. The drift gillnet may be fished from a drum in a manner similar to salmon drifting. This method is not widely used in Alaska (Table 64).

The Pound - Pounds have been used in Alaska both for trapping and keeping live bait herring for the different fisheries that need them. Pounds are heavy-net enclosures attached to floating logs, with a lead extending from the body of the pound, making it act as a trap. A modified version of the pound was used in British Columbia for the purpose of propagating herring spawn on kelp. Pounds in Alaska are presently restricted from using herring for any purpose other than for the sale of fresh bait. In this respect, Alaska law has restricted the entry of live bait fishermen into a lucrative sideline occupation. In 1976, there were three pounds recorded by Alaska Department of Fish and Game, all in Southeast Alaska.

Trawls - Although the major users of trawls are Russia and Japan in the Eastern Bering Sea, there has been comparatively little directed trawling efforts for herring by Alaska fishermen. The Alaska Department of Fish and Game reports one effort at trawling for herring in 1976 around Kodiak Island.

Hand Tools - Although ADF&G prohibits the collection of herring roe on kelp in Southeast Alaska, it is allowed in all other areas. Prince William Sound is a major source of the product. Since 1977 collection has been limited to hand cutting the kelp. Mechanical devices for shearing or raking the kelp are prohibited.

The Role of the Tender

Most of the vessels under discussion have very little holding capacity, especially in the event of an exceptionally large haul. This condition is even more apparent in the set gillnet fishery, where the vessel often used is a bare skiff with no refrigeration facilities. In order to accommodate participants of a short seasonal fishery who do not wish to waste time going to and from the processing plant, the company-owned or

TABLE 64

A COMPARISON OF HERRING FLEET CHARACTERISTICS
FOR MAJOR AREAS IN ALASKA IN 1969 AND 1976

1969 Herring Fishery Participants

Boat Length	Number	Total Net Tons	Catch	Number of Landings	Gross Earnings	Earnings/ Ton
Southeast Alaska						
Purse Seine						
Unknown	1	*	*	*	*	*
46 - 55	6	167	5,938,756	114	118,775	40
Prince William Sound						
Purse Seine						
26 - 35	3	*	*	*	*	*
36 - 45	2	*	*	*	*	*
46 - 55	1	*	*	*	*	*
Cook Inlet						
Purse Seine						
1 - 25	1	*	*	*	*	*
26 - 35	5	48	1,598,173	42	31,963	40
36 - 45	3	*	*	*	*	*
46 - 55	2	*	*	*	*	*
Kodiak						
Purse Seine						
Unknown	4	0	334,135	16	6,682	40
26 - 35	9	75	1,088,373	47	21,767	40
36 - 45	3	*	*	*	*	*
46 - 55	2	*	*	*	*	*
Otter Trawl						
46 - 55	1	*	*	*	*	*

TABLE 64 (Continued)

1976 Herring Fishery Participants

Boat Length	Number	Total Net Tons	Catch	Number of Landings	Gross Earnings	Earnings/ Ton
Southeast Alaska						
Purse Seine						
Unknown	2	*	*	*	*	*
1 - 25	1	*	*	*	*	*
26 - 35	2	*	*	*	*	*
36 - 45	10	189	1,173,603	22	101,525	173
46 - 55	25	819	11,350,037	259	789,295	139
56 - 65	2	*	*	*	*	*
66 - 75	2	*	*	*	*	*
Set Gillnet						
Unknown	5	-	67,747	10	9,145	270
1 - 25	36	33	325,623	77	43,959	270
26 - 35	39	207	1,099,435	105	148,423	270
36 - 45	13	140	141,430	22	19,093	270
46 - 55	7	250	83,254	10	11,239	270
Fish Traps	3	*	*	*	*	*
Prince William Sound						
Purse Seine						
Unknown	5	-	397,826	8	34,610	174
26 - 35	33	345	2,224,067	48	193,493	174
36 - 45	27	446	2,390,479	38	207,971	174
46 - 55	2	*	*	*	*	*
Drift Gillnet	1	*	*	*	*	*

TABLE 64 (Continued)

1976 Herring Fishery Participants

Boat Length	Number	Total Net Tons	Catch	Number of Landings	Gross Earnings	Earnings/ Ton
Cook Inlet						
Purse Seine						
1 - 25	1	*	*	*	*	*
26 - 35	23	255	3,187,106	154	312,336	196
36 - 45	35	545	5,464,892	230	535,559	196
46 - 55	7	246	960,038	33	94,083	196
Kodiak						
Purse Seine	1	*	*	*	*	*

Source: Commercial Fisheries Entry Commission; Alaska Department of Fish and Game.

*All data have been deleted in categories containing less than four boats.

independent tender is available to take a fisherman's catch into port. This catch may be brailed onto the tender, which is equipped with holding space and may be equipped with weighing apparatus. Some tenders may have sophisticated refrigeration systems; others operate without any refrigeration at all. In the case of the herring roe fishery where ex-vessel price of the roe is determined by average roe yield, the tender sometimes is responsible for determining the roe yield for the catch when the fisherman delivers to the tender.

Gear Advantages and Disadvantages

Since the entry of Japan into the herring roe market, there has been a gradual shift away from the use of the purse seine for the roe herring fishery in favor of the set and drift gillnet. The first set gillnet fishery in Southeast Alaska in 1976 was a moderate success. Despite the problem of loss of fish falling out of the net during retrieval, and the occasional damage done to fish when removing them from the net, the use of the gillnet in the herring fishery has the following advantages (Ness 1977b and 1977c):

1. Gillnets allow for a slower rate of harvest. Landings are more evenly spaced as a result and this facilitates the processing of a product of high quality.

2. Because gillnets are selective of age, sex, and maturity, the sex ratio is weighted in favor of females, which tends to reduce processing costs. The size of the fish is more uniform, and as a result, cost savings can be experienced both in grading, sexing, and further mechanical processing.

The purse seine advantage lies in high volume. However, this comes at the cost of size selectivity.

Both purse seines and gillnets are regulated by limited entry laws in Southeast Alaska, Cook Inlet, and Prince William Sound. Limited entry was instituted in 1977 for the purse seiners and early in 1978 for the gillnetters in all three areas.

Processing Technology

Herring Production in Alaska and British Columbia

Until the mid 1960s, the herring processing sector in Alaska was established on the reduction of fat herring to meal and oil. Today, however, the reduction process is used to meet EPA standards. The most notable experiment in the processing of waste fish for this purpose is that of Bio-Dry in Kodiak (Thomas 1976). With some equipment salvaged from New England Fish Company's old reduction plant in Kodiak, Bio-Dry has revitalized the reduction process to include not only herring meal, which is presently only a small part of the waste, but also crab and shrimp waste.

However, for the most part, the herring processing sector in the 1970s is characterized by Japanese processing methods or the traditional (and simpler) bait processing operations. Although the American and Canadian processors' involvement with Japanese markets has required them to adopt Japanese methods, they have also influenced Japanese entrepreneurs to change some of their own habits of buying and selling herring roe. For example, Japanese use Korean processing plants for extracting roe from fish caught in Alaska and avoid high costs of American processing. Although the Japanese demand for herring roe seems to be very strong, the limited nature of the market places the American and Canadian processors in a precarious position, especially if other sources of supply are tapped by the Japanese. On the opposite end of the marketing chain, the sporadic nature of the herring populations contributes to this boom and bust situation which seems to be characteristic of the sac roe fishery. Between these two extremes are the Alaskan processors who, with the help of a Japanese technician or export agent, engage in an export market that is highly complex. The success of a venture in the marketing of herring roe in Alaska is often dependent on the success of herring fisheries in other countries such as Canada.

The bait fishery, on the other hand, supplies a domestic market which can easily be followed by noting the success of the crab and halibut fisheries, the primary user groups of herring bait.

Technology for canning herring has been largely explored by the Canadians. The production of canned small herrings known as "sardines", so common in New England, is non-existent in Alaska. The market for herring fillets as specialty foods has only recently been expanded, but is now an important alternative market to bait. However, it is expected by some sources in industry and government (Ness 1978; McCarthy 1978) that present world fishery trends will give American processors a comparative advantage in international trade in the near future. Canada's East Coast also offers competition in herring export to Japan. When the Japanese Ministry of International Trade and Industry issued import licenses for an additional 25,000 tons of herring in various stages of processing in late 1977, 15,000 tons of the import quota was Atlantic herring.

Figure 20 describes the major processing areas in Alaska for the year 1976. The two major areas are Southeast Alaska and the Kenai Peninsula. In addition to the areas located on the map (these are all landbased processors), a number of buyer ships and some mobile freezer ships cruise the areas around Kodiak, Cook Inlet, Prince William Sound, and parts of Southeast Alaska. However, these play a minor role compared with the production of the whole state. The production of herring meal and oil had been steadily declining until 1970, when some interest was generated because of world shortages in soybean crops and poor anchovy catches in South America. Frozen whole and bait herring have been produced consistently, though the emphasis now is on freezing whole round roe herring for export to Japan. According to Alaska Department of Fish and Game preliminary estimates for 1976 (Appendix X) of the total value of the herring fishery at the producer level, 91.48 percent is attributable to roe and roe on kelp, (and includes frozen roe herring for export to Japan), 6.67 percent to bait, and 1.85 percent to meal.

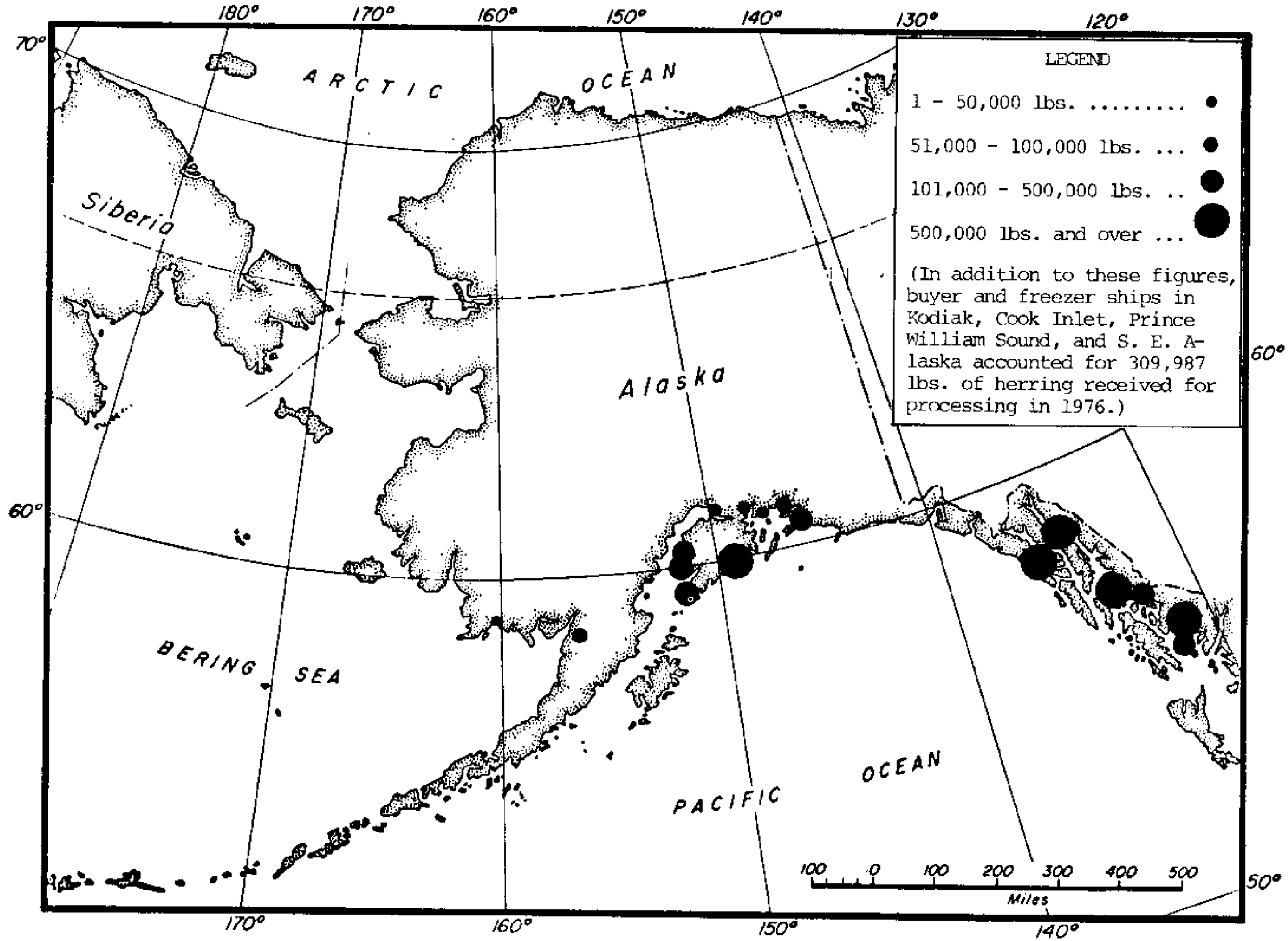


FIGURE 20. MAJOR ALASKA PROCESSING AREAS FOR HERRING, AND THE RELATIVE IMPORTANCE OF EACH AREA BASED ON 1976 PROCESSORS' REPORTS.

A similar occurrence is paralleled in British Columbia (Table 65) with exceptions of some canning for human consumption, and in recent years a large amount as frozen food, most of it as frozen roe for export to Japan.

Herring Sac Roe Processing

The herring sac roe fishery began in the early 1960s amid considerable opposition to the wasteful methods of producing the first product. The public outcry was against the practice of letting the herring spoil for several days before extracting the roe. This made the operation of extraction fairly simple, since the roe from the spoiled fish was less likely to break open. In addition to the wasteful aspect of letting flesh rot, the whole carcass was usually returned to the ocean. Later, the Environmental Protection Agency (EPA) passed regulations that required the grinding of these remains in a slurry of water and their release in at least seven fathoms of water. Subsequently, the Alaska State Legislature issued a policy statement that prohibited waste of herring flesh (16 Sec. 10. 172-173). This legislation went into effect on January 2, 1978, except for the Bering Sea north of 56° latitude which became subject to the law on January 1, 1979 (Edfeld 1978). The new statute, although it may have been needed from an environmental standpoint, placed processors in a difficult position with regard to herring roe processing. Their options were:

1. Brine all of the herring, sex them, and extract the roe. However, the remaining carcasses do not produce a good quality fillet or meal because of the high salt content.

2. Freeze all of the herring; later extract the roe and produce fillets and high quality meal. However, this method is uneconomical since the males do not enter into roe processing but are frozen anyway.

3. Sex the herring by hand prior to brining or freezing. However, manual methods of sexing are tedious and time consuming. For example, Liem and Devlin (1976) comment that:

> These hand sorting units were tried out by one company and it has found that one person could handle .22 tons per hour or 2.2 T/10 hour shift...the accuracy of the sorting is entirely dependent on the conscientiousness of the processor and the use of mature herring; i.e., gillnet herring.

The process of either brining or freezing roe herring is important because this toughens the skein of eggs in much the same way that putrefaction did when it was practiced. However, subjecting the male herring to the same treatments as the females was not economically feasible. A solution to these problems appears feasible through the use

TABLE 65

VALUE ADDED FROM PROCESSING HERRING PRODUCTS IN B.C. 1964 TO 1976

Year	Herring Landings (tons)	Products Produced: Oil (000 lb.)	Products Produced: Meal (tons)	Products Produced: Canned (48 lb. cases)	Products Produced: Roe (tons)	Frozen Food (000 lbs.)	Landed Value to Fishermen: Total ($000)	Landed Value to Fishermen: Per Ton $	Value Added in Processing[2]: Total $000's	Value Added in Processing[2]: Per Ton	Market Value: Wholesale Value $000's
1964	252,643	44,902	46,071	N/A[1]	N/A[1]	18	6,167	24.40	5,394	21.35	11,561
1965	222,031	43,442	41,509	N/A[1]	N/A[1]	38	6,232	28.06	5,520	24.86	11,752
1966	153,826	27,560	27,058	---	N/A[1]	14	5,107	33.19	3,198	20.79	8,305
1967	58,370	8,735	10,499	---	---	96	1,828	31.31	810	13.89	2,638
1968	3,186	N/A[1]	N/A[1]	N/A[1]	N/A[1]	74	231	72.50	100	31.39	331
1969	2,208	---	---	---	N/A[1]	430	221	100.09	338	153.08	559
1970	4,260	---	---	---	N/A[1]	3,417	290	68.07	392	92.02	682
1971	11,041	N/A[1]	N/A[1]	N/A[1]	N/A[1]	9,384	556	50.36	1,700	153.93	2,256
1972	43,013	N/A[1]	N/A[1]	N/A[1]	5,484	14,722	2,726	63.37	9,886	229.84	12,612
1973	61,315	2,438	4,716	N/A[1]	8,534	27,566	10,951	178.60	23,690	386.36	34,641
1974	49,240	N/A[1]	N/A[1]	N/A[1]	9,249	8,340	12,043	244.58	17,813	361.76	29,856
1975	65,740	N/A[1]	N/A[1]	44,852	9,785	23,061	13,267	201.83	21,600	328.57	34,867
1976	89,402	N/A[1]	N/A[1]	N/A[1]	15,912	28,156	23,442	262.09	41,658	465.96	65,100

Source: Government of Canada, Fisheries and Oceans. British Columbia Catch Statistics, Annual Summary.

[1]N/A: Not available, less than three firms reporting.

[2]Value added due to labor overhead, processing, packaging, administration, and transportation costs, plus profits.

of automatic herring sex sorters. Two companies that pioneered in the building of sex sorters are Neptune Dynamics, which is associated with the Sweden-based company Arenco, and Techwest Enterprises, Ltd., of Vancouver, British Columbia. Liem and Devlin (1976) determined, in the 1976 herring sac roe season:

1. The herring sex sorting machines--two of which were used in Alaska--worked well for fisheries where gillnetted herring were used.

2. The sex sorting machines (Neptune Dynamics in conjunction with the filleting machine produced by Arenco), had automatic female recovery and milt production rate of 2.5 ton/hour with 83 percent yield of females. This rate required 14 people on the line to box and freeze whole fish, and 34 people to strip and freeze roe (Table 66). Slower processing times with hand sexers could yield as high as 95 percent roe herring.

3. The set-up allowed the processor to produce a high grade meal or fillet without the salt problem in the final product.

4. The sexer allows the processor to retain the option of removing the roe at the plant to process it or to enter the whole frozen fish on the foreign market.

In an updated discussion with Liem (1978), the author was told that substantial improvements in the automatic herring sexer have taken place, enabling the machine to produce at the same rate as the original model but with a higher percentage of females at 95 percent. The electronics used in determining sex have been perfected and are now more reliable.

The processing of herring roe from the time it is caught to the time it is shipped in most cases is tightly controlled by the Japanese buyer. Technicians are assigned to oversee the processing and provide technical and quality control advice. In some cases, these Japanese technicians are a determinant in the success of trading on the Japanese wholesale market. Price variability on the trading floor is a function not only of the roe condition on arrival in Japan and other demand factors, but also of the name of the technician on the boxed product (Doyle 1978).

Specific methods of processing vary among plants, but generally follow the diagram shown in Figure 21. The product, when finished, may be either dried, salted, or brined. The form, when leaving the United States or Canada, is usually in tightly packed 50-pound boxes or in five-gallon containers topped off with salt. Their destination is usually Hokkaido wholesale markets in Northern Japan where they will be bid upon by small processors. These shipments have been graded at the plant in the exporting countries into numbers 1, 2, 3, 4, and immature, according to size and maturity of roe, and are bid upon by those categories. The buyers in Hokkaido, in turn, further process the roe by regrading, drying, removing excess salt, and breaking the packages into smaller portions for the final consumer (Sonu 1978). The final product then

TABLE 66

A COMPARISON OF SEXING, FREEZING AND BRINING OPERATIONS
WITH ATTENDANT EQUIPMENT COSTS FOR 1976

Operation	No. of Persons Required	Amt. Frozen (Tons)	Equipment Cost	Herring/Roe Production	
Sexing Line With:					
1) No Female Recovery					
a) Frozen Export	5	12-1/2	$35,000	12-1/2T-80%	herring
b) Frozen-Stripped	25	12-1/2	$35,000	2-1/2T	roe
2) Female Recovery (Manual)					
a) Frozen Export	10	15	$37,500	15T-83%	herring
b) Frozen-Stripped	30	15	$37,500	2-1/2T	roe
3) Female Recovery (Automatic)					
a) Frozen Export	8	15	$53,500	15T-83%	herring
b)	28	15	$53,500	2-1/2T	roe
4) Fillet Line					
a) Milt Prod.	4		$20,000	2T	milt
b) Fillet Prod.	2			3-1/2T	fillet
Boxing/Freezing LIne					
a) Frozen Export	3	25		25T-50%	herring
b) Frozen-Stripped	31	25		2-1/2T	roe
Brining	27	3-1/4T salted		2-1/2T	roe

Source: Liem and Devlin (1976).

goes to one of many wholesale markets, the most consistently reported one being the Tokyo wholesale market.

The grades for bidding in the Tokyo market are: extra large (mature); large, medium, small, and immature. The prices of the final product, ready for the consumer, sold for as high as $15 per pound in 1977 for number 1 grade only. However, number 1 grade makes up only a very small percentage of all herring roe graded and sold. Other grades may sell for much less. Ultimately, the difficulty in the herring roe business is being able to make money by assuring high grade product, which may depend on a number of factors that are outside the processor's control.

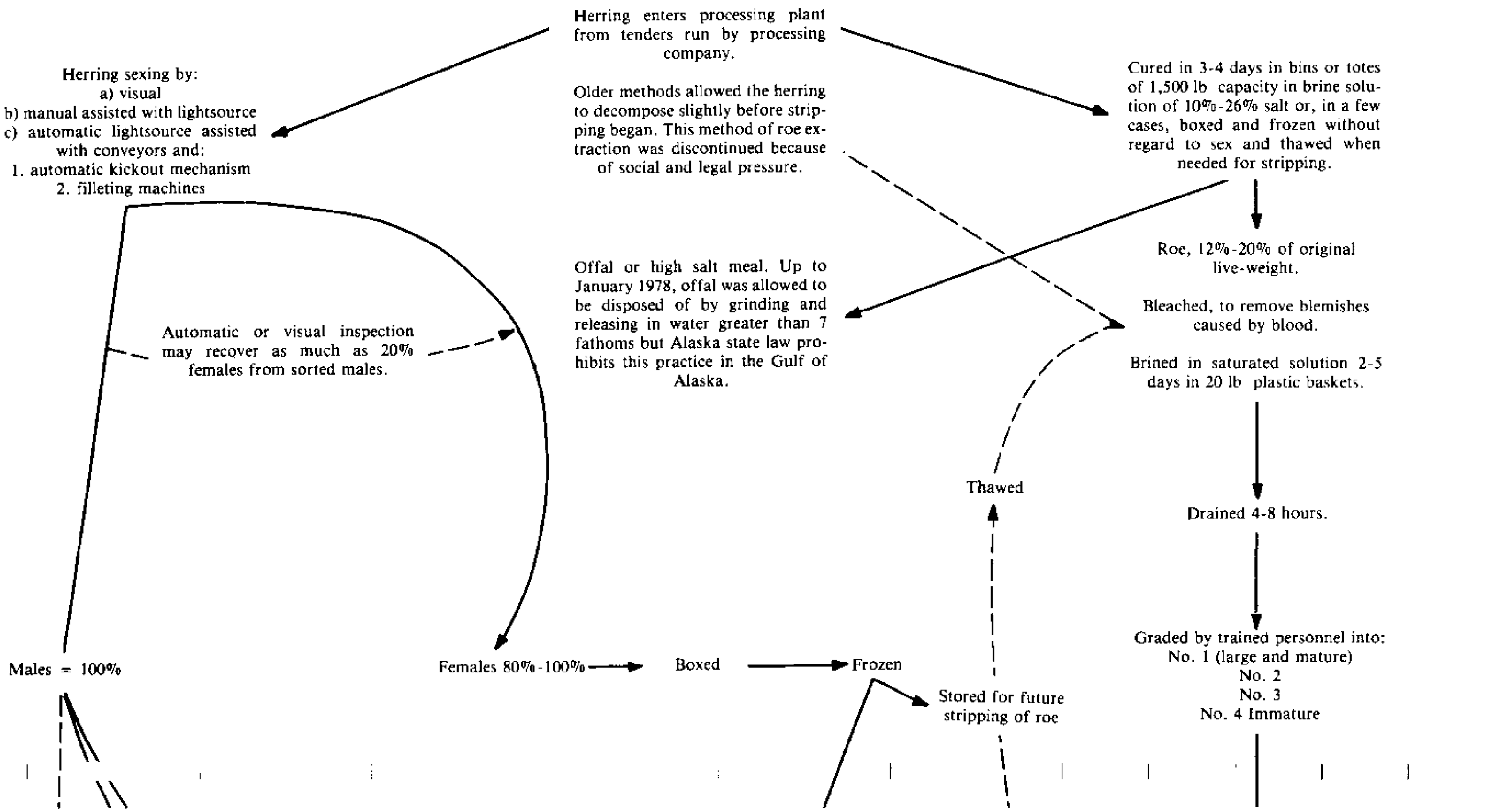
Other methods of semi-processing involve the straight export of the whole herring in large tote containers to either Korea or Japan. Although there are no restrictions on import of herring roe to Japan, there are restrictions on import of whole frozen, or brined herring regardless of whether or not they are gravid with roe. Authority to restrict the importation of whole herring has been informally delegated by the Ministry of International Trade and Industry (MITI) to a Hokkaido fisherman's cooperative. This development occurred because of the difficulties this group has had with declining herring stocks and being squeezed out of USSR territorial limits, where much herring fishing has previously been done (Atkinson 1978). Essentially, then, most government requests and directives are at the request of Hokkaido Fisherman's Cooperative. This places processors in the U.S. and Canada in a precarious position with regard to permanence of market conditions favorable to investment in capital equipment and processing methods for Japanese markets. It also tends to discourage developments in markets for herring products other than roe. The well-worn question arises: How much trade should the U.S. allow with a country that has a high degree of protectionism?

Herring Roe on Kelp Processing

The Alaskan herring roe on kelp fishery and processing is characterized by a relatively simple harvesting technology and a processing and distribution technology that is in many ways similar to herring roe (Figure 22). Again, the processing is under the direction of Japanese buyers. The demand for different types of kelp varies significantly, and the following in decending order have some commercial value attached to them: *Macrocystis sp*. (giant kelp), *Laminaria sp*. and *Agarum cribrosum* (seive kelp).

The kelp is graded and washed in seawater to remove sand. Bare sections that are not covered with egg masses are discarded. The remaining sections are brined in tubs of saturated saline solution for eight to 12 hours. The kelp is then drained and dried, and final packing is in five-gallon containers packed with salt. The processing of herring roe on kelp is under the supervision of a technician either supplied by the buyer or independent import-export operators as in the processing of sac roe.

The success of a pack of herring roe on the Japanese market depends almost entirely on the work of the Japanese technician, who is highly trained and hired by the buying company to oversee operations in an American or British Columbia based firm. Sometimes the technicians may include an entourage of trained graders from Japan. The intensity of grading is in accordance to demand in Japan. However, for optimal conditions, the herring carcass must yield 10%-15% roe by weight. Female-male sex ratio, age, race, and roe maturity are all factors bearing on roe development.



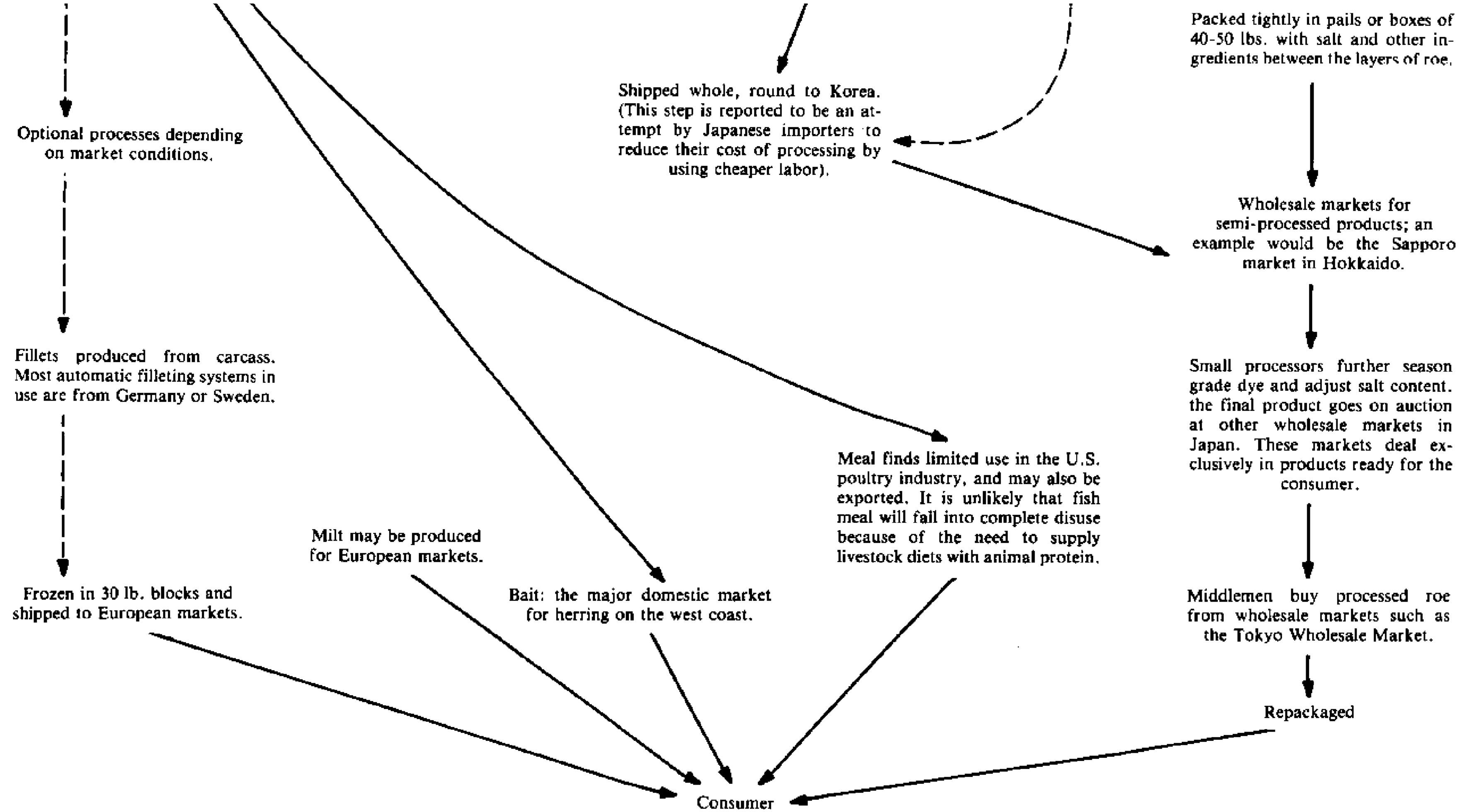


FIGURE 21. SPRING HERRING ROE PROCESSING METHOD

The processing methods of the roe on kelp fishery in Alaska differ from those used in British Columbia. I include it here for comparison because the British Columbia product has wider acceptance in Japan.

British Columbia fishermen, (usually bait fishermen) are licensed to use impoundments for retaining gravid herring and kelp, usually *Laminaria* sp or *Macrocystis* sp

↓

Kelp is collected and strung across ponds and attached to sides of the pound.

↓

Gravid herring are purse seined and released alive in the pond.

↓

Roe on kelp is gathered, placed in 1,000 lb. plastic boxes and packed in pickling salt.

↓

Herring may be retained as bait.

↓

Direct negotiations with Japanese buyers. Price in 1977 $4-$5.25/lb FOB B.C.

Fishermen are permitted to take herring roe on kelp in Prince William Sound, Cook Inlet, and Bristol Bay areas using hand cutting devices only. The principal species of kelp collected area:

↓

Ribbon kelp — *Laminaria sp.*
Giant kelp — *Macrocystis sp.*
Sieve kelp — *Agarum cribrosum*

↓

Graded by processors according to:
a) thickness and extent of egg covering
b) how clean the kelp is of dirt & sand
c) type of kelp.

↓

Washed in sea water.

↓

Brined in saturated saline solution.

↓

Dried, packed, and salted in 50 lb pails or boxes.

↓

Shipment to:

↓

Markets specializing in semi-processed products (i.e., Hokkaido).

↓

Small processors buy and package the product for sale to final consumer. Herring roe on kelp is a holiday food.

↓

Wholesale markets for processed product, i.e., Tokyo wholesale market.

↓

Middleman

↓

Consumer

FIGURE 22. COMPARISON OF THE ROE ON KELP PROCESSING METHODS IN ALASKA AND BRITISH COLUMBIA

The specific methods of processing are, in most cases, closely guarded secrets (Doyle 1978). However, new processes developed by Japan apply loose roe to kelp up to one-eighth inch thick on both sides. This new development has depressed the price for herring roe on kelp in Prince William Sound (Fergeson 1978).

The Bait Fishery

This is practically the only domestic use of herring. Fortunately, it is also one that provides a market that requires no specialized treatment except harvesting at the correct time. The bait fishery also has the potential of supplying a larger market of high quality fillets to Europe, if foreign import restrictions are eased and if retail prices in foreign countries rise enough. Bait herring are usually boxed and frozen and may be used in the halibut, salmon, or crab fisheries (Figure 23).

Fillet and Milt Production

One processor in Alaska actively sells fillets and milt to Europe. Fillets are produced on machines built in Sweden, Denmark, Norway, or Germany. This process may operate in conjunction with the herring sac roe processing. Further processing in Europe may yield specialty herring foods: roll mops, pickled fillets, herring fillets in wine sauce, and a number of other items that are favorite foods of specific countries.

Processing Capacity and Capacity Utilization

Determining processing capacity and outlining production for the industry in a unit of time under a rigid set of assumptions is extremely difficult because of the absence of data on the physical capacity of processing methods and equipment. However, general inferences can be drawn from the catch statistics (Table 62) and the development of the industry through time. For example, by the early 1960s, a clear case of overcapacity existed when there was a demise of the markets for reduction products from Alaska. Up to that time, firms closed down and capacity contracted to a point where only one herring reduction processing plant existed in 1965. When the Japanese expressed interest in herring roe products, there was a lag in gearing up for directed production and marketing.

The present well-being of the industry appears to depend on the resource as well as the stability of the market. This raises the question of how well the resource has been managed or, conversely, how well fisheries managers can be expected to predict the success of the fishing sector's activity. When the problem is stated in this manner, it becomes clear that the long-run economic efficiency of the processing sector is directly

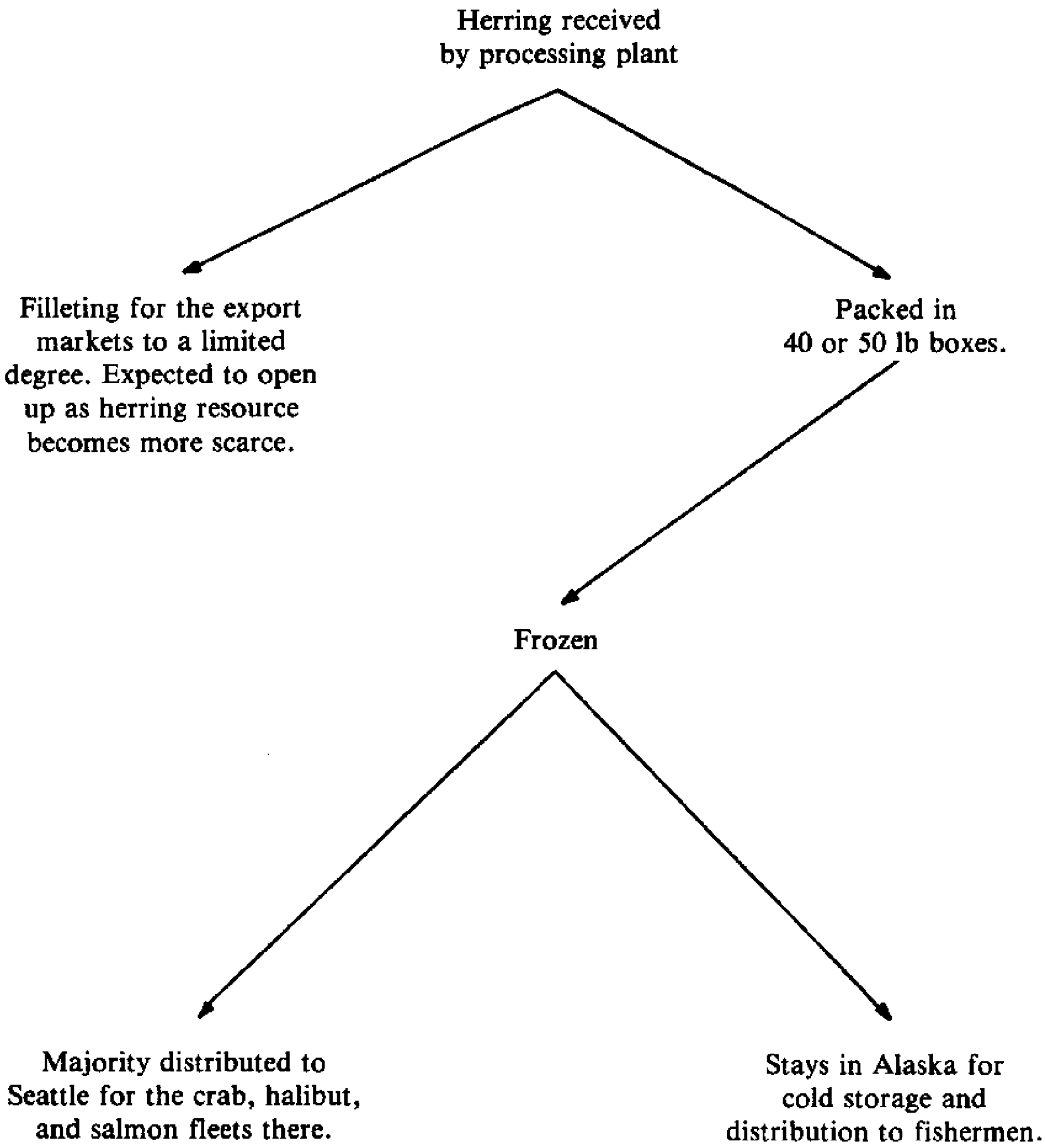


FIGURE 23. FALL AND WINTER BAIT PROCESSING METHODS

tied to the successful management of the resource and the market, regardless of how the management may be arranged institutionally. In years where the fishery fails, there is rampant overcapacity due to idle resources that have no alternative employment. When the fishery is successful, there may be temporary undercapacity over the peak catching period, although this has not occurred in the last five years. As the fishing season shortens, undercapacity becomes more probable. In the event that fixed capital equipment is unadaptable, the returns over the short season must be weighed against idle capacity for the rest of the year.

The major feature that separates the fishing sector from the rest of the agriculture industries is the relatively greater uncertainty involved in procurement of the resource which is apparently the result of a limited understanding of some fish populations. The resulting cost of imperfect knowledge of the fishery resource is borne by the industry in the form of temporary idle capacity. However, the cost of poor management of the resource in the long run or inefficient use of the resource is chronic overcapacity and business failure.

CHAPTER X

MARKETS, PRICES, DEMAND AND PROJECTIONS FOR HERRING

The Decline of the Herring Reduction Industry

Until the mid 1960s, herring had been used principally as an industrial fish in the United States. For example, a 1968 commodity report on herring published by the Bureau of the Census cites that:

> In recent years, slightly over half of the consumption was used in the manufacture of fish meal for use in animal feed and fish oil; about one third was canned; and most of the remainder was used in the preparation of canned pet food or fish bait.

The principal link between the consumer and the herring fisheries was indirect through other industries that used herring products. The difficulty that the herring fisheries had was a result of changing technologies that occurred in those industries that used herring products.

The herring reduction industry collapsed in the wake of a series of developments in agriculture and industrial chemistry as well as other competing fisheries:

1. The technology which developed around synthetic detergent chemistry beginning in the 1930s reduced the need for fish oil in some soap making processes. By 1954, synthetic detergents had well established markets.

2. The menhaden fishery of the Atlantic and Gulf Coast expanded in the late 1950s. Menhaden, also a herring-like fish, was a strong substitute to the ever-shrinking herring fishery.

3. In the late 1950s with the help of FAO and large American investment, Peru discovered the anchovetta fishery. This fishery became a boom fishery in the mid 1960s, that almost completely obscured both the menhaden and herring fishery, and drove world prices of meal down to less than under $80 per ton (Ness 1977a). Appendix XI charts the expansion of this important development in the world production that affected not only Alaskan fish meal production, but production of fish meal in the U.S. as well.

4. Research in agricultural production and processing of soybeans, with the help of government subsidies, gave livestock managers an alternative to high-priced fish meal. With the help of advanced production economics, poultry producers and cattlemen could determine optimal combinations of feed, subject to other constraints of production and the output level they desired. Fish meal, although not a feasible direct substitute for soybean or corn, is required in fixed quantities proportional to the expected total output of live-

stock. In this regard, the quantity of fish meal demanded should vary more with the actual numbers of animals in feeder operations rather than with the price of other feed grains.

It is important to understand just how great an effect government subsidized agricultural development of soybean production may have had on the herring fishery. Since the production process of poultry and beef are well defined and have also been accurately administered, the critical relationship between the price of soybean meal and that of fish meal is carefully monitored by the National Marine Fisheries Service (NMFS) and the government's document Agricultural Statistics. Appendix XII shows the production of soybean meal, cake, and oil, as well as support and finished product prices. For the period shown (1939 to 1975), the gradual increase in the production of soybeans can be traced. It is roughly analogous to the demise of herring processing for oil and meal.

However, during the early 1960s, the Alaska herring fishery still found outlets for some meal, oil, and bait. In addition to this, Alaska processors from Kodiak were developing markets in Japan for herring roe. In the early 1970s a reversal of the events which caused the poor herring meal and oil prices earlier occurred when the Peruvian fishery and the world soybean crops both suffered a collapse in 1971 and 1973, causing a drop in production of meal for the years 1972 and 1974 (Appendix XII). These developments caused a temporary recovery of the herring oil and meal markets.

Pricing

Overview

The two principal uses of herring bait and roe generate their own respective prices. Pricing for the bait market may be established through negotiations between fishermen's groups and processors, or may consist of a loose arrangement between a fisherman and processor. In either sense, the negotiated price is arrived at in consideration of demand factors that exist within the U.S. The bait market, therefore, appears to be fairly straightforward, although little price data exists. Pricing for the roe herring and roe on kelp fishery has its beginnings in negotiations between processors in Canada and Japanese entrepreneurs.[1] The resultant success or failure of Alaska's neighbor, both in negotiations and the herring catch, determines if the opening bids in Alaska by the Japanese will be weak or strong.

Some other determinants of price are the import allowance of herring by the Japanese government; the degree of collusion among buyers; the perceived consumer demand in Japan; the Alaska Department of Fish and

[1] These are usually Canadian and Japanese trading companies that then deal with Japanese processors and storage specialists in Japan.

Game (ADF&G) quotas, the quantity of whole herring or roe which is frozen and held as inventory, both in Japan and in Alaska; the value of the U.S. dollar versus the yen; and, of course, the product grade or quality.

Buying behavior of the Japanese is sometimes different in Alaska than in Canada. Canada has led consistently in the export of semi-processed roe to Japan because she places bans on sale of whole frozen roe herring. In 1977, Canada raised its export ban from 75 to 90 percent, which means that virtually all of Canada's roe herring catch is processed in Canada. As a result, Canada is a dominant market force in Japan's semi-processed roe markets and their prices in the wholesale market are published regularly by Japanese trade journals. Alaska has no such ban, provides very poor exvessel price data for both roe and bait herring, and a regular tabulation of Japanese wholesale prices is non-existent. The tendency for Japanese buyers to do out-of-country processing is increasing, judging from the amount of frozen roe herring that Alaska processes. However, some sources (Kitano 1978) suggest that this trend may reverse since the cost of American labor has become "affordable" due to the devaluation of the dollar against the yen.

Exvessel Prices

Exvessel spot prices for the major herring products are virtually non-existent for Alaska. However, several reasons for the lack of this data are evident. Herring, besides being a sporadic fish resource, is also put to a number of uses. Some of these uses are seasonal. Thus, it is fair to say that a ton of herring in the spring is an entirely different product from a ton of herring in the winter or fall. Added to this problem is the fact that roe yields determine unit price; in this case, the unit price is a ton.

Consider the variability in what little information is given by NMFS Fishery Market News Reports on the Puget Sound sac roe fishery. In 1978, the per-ton "price" was consistently "about $1,000," depending on an average recovery of 11 to 13 percent. Kodiak, the only reporting section in Alaska, recorded herring sac roe per ton prices from $77 (four percent recovery) to $726 (no recovery listed). Just two days later, Kodiak reported an exvessel per ton "spot price" of $450 to $1,250 with $500 being the price given in the highest frequency. The bait fishery exvessel prices are again very incomplete for Alaska. The prevailing price for bait herring in Kodiak in 1978 was $275.

The next-best option is to devise average exvessel value from ADF&G fishery leaflets. However, since it would be impossible to look at individual herring markets, this data would be of little use. Prices to the harvester for herring roe on kelp are also scarce; the only ones available in this report came from Alaska Department of Fish and Game estimate of price per pound for Cordova in 1978. Laminaria, a ribbon kelp, is reported to have sold in Cordova at approximately $1.50; sieve kelp sold for $1.25; hair kelp brought an even lower "exvessel" price of $.75 (Pirtle 1978). The actual price per pound is determined by how free the product is of sand and mud, and the thickness of the egg mass.

Wholesale Prices

Wholesale prices for herring products in Alaska are limited to the ADF&G production statistics, and some spot prices that are available through the NMFS Fishery Market News Reports. Derived wholesale prices from ADF&G production statistics is a possible source. However, spot wholesale prices for Alaskan herring products are almost as scarce as exvessel prices. In regard to the ADF&G statistics, they are far too aggregated to be of use in a serious economic study.

For instance, the Department of Commerce does produce some relevant summaries showing the fish meal production, per-ton prices, imports, chicken placement, and price ratios of fish meal to soybean meal for the major industrial fish. However, in this summary, herring is listed in "other," since it comprises a minor part of the market. It is also not immediately apparent to the reader, but is important to those concerned with the suitability of fish meals in animal rations, that the percentage crude protein in herring meals may be as high as 74 percent compared to 60 percent for menhaden and 55 to 65 percent for anchovetta; and fish meal wholesale prices generally reflect that protein difference. Thus, in June 1977 for Canadian herring meal prices per ton (70 to 74 percent at Boston) were $560 to $592, compared to $425 to $430 for menhaden (60 percent at New York); $407 for domestic anchovy (55 percent at Los Angeles); and $425 to $430 for Peruvian anchovy (65 percent at New York).

Another example of the "aggregation" problem is the treatment of wholesale prices of herring roe and roe on kelp in Alaska. Herring roe is graded at least twice (see Chapter IX) according to maturity and size, and these gradings carry with them sizable differences in the wholesale price (Table 67). In addition, there are usually three "wholesale markets," one in Alaska and two in Japan, for both herring roe and herring roe on kelp. These market channels are very well-defined for Canadian products, but it can only be assumed that the same channels are taken by the Alaskan product. However, this is an assumption that should be substantiated by further study. Heterogeneity of the product due to a sophisticated grading technique used by Japan is again not reflected in the production statistics of either the United States or Alaska.

Although bait herring is a "homogeneous" product, wholesale spot prices are not available for the fishery. This may result from the local nature of the product distribution. However, in a telephone contact with a bait processor in Southeast Alaska, the writer was quoted a wholesale bait price of $8.35 per box (30 lb) and a per-ton price of $500 in July 1978.

Consumption

The Alaskan herring fishery is actually involved in only two major markets; the domestic bait market and the herring product export to Japan, mainly for the roe markets. The small production of meal and

TABLE 67

WHOLESALE PRICE RANGES OF CANADIAN HERRING ROE AT TOKYO WHOLESALE MARKET BY MONTH WITH YEN/DOLLAR CONVERSION

	1977				1978	
Grade	Sept	Oct	Nov	Dec	Jan	Feb
Extra Large	8.08-8.20	8.36-8.71	8.91-9.27	9.89-10.14		10.25-10.44
Large	7.69-8.20	8.01-8.36	8.91-9.09	9.20- 9.76		10.05-10.25
Medium	7.69-8.03	7.84-8.36	8.55-8.73	9.01- 9.39		9.67- 9.86
Small	8.03-8.37	8.19-8.53	8.55-8.91	8.45- 9.01		9.28- 9.67
Dates Covered	21-29	4-22	2-10	9-26		18
Yen/U.S. Dollar Conversion	266:1	261:1	250:1	242:1		235:1

	1978					
Grade	Mar	Apr	May	June	July	Aug
Extra Large	10.44-10.86	10.95-11.36	11.76-12.75	11.76-13.63	13.18-13.86	14.27
Large	10.05-10.25	10.53-11.77	11.76-12.36	11.56-13.41	12.95-13.63	13.80-14.27
Medium	9.67-10.07	10.33-11.36	11.36-11.96	11.16-12.98	12.50-13.40	13.32-13.80
Small	9.28- 9.68	9.91-11.36	10.36-10.96	12.55	12.27-12.72	13.08-13.32
Dates Covered	4-30	4-27	12-27	9-30	12-22	7-19
Yen/U.S. Dollar Conversion	235:1	220:1	228:1	210:1	200:1	191:1

Source: National Marine Fisheries Service, Foreign Fishery Information Release, monthly.

specialty foods is completely overshadowed at present by other sources of supply that are nearer. However, this may change with a growing demand by Europe to supplement their depleted resources with U.S. herring for specialty food items.

Alaska market relationships with Japanese buyers are highly complex, and involve dealing with a consumer whose tastes are alien to Western nations. The matter is further complicated by foreign exchange rates, the wide diversity of potential buyers in Japan, the unique method through which the product is wholesaled in Japan and the lack of knowledge of what "sells" in Japan. Surprisingly, the herring roe market also seems to be the only successful herring product venture with which Alaska has been involved. Yet, despite Alaska's monopsonistic relationship with Japan, neither the U.S. nor Alaska have developed export statistics or price data relating to this market. To the writer's knowledge, there has been no widely read work on Japanese consumer behavior toward herring products. Neither has there been any open discussion of the long-range stability of Alaska's share of the market in Japan. The consequences of these omissions in market knowledge may have already taken a heavy toll on the domestic herring fishery, and could have disastrous results in the future.

Consumption of Herring Roe on Kelp and Herring Roe

The Japanese consume herring roe products in a number of ways which include use in Sushi or other small appetizers, mixed with rice-flour paste with pieces of tuna, or sprinkled with soy sauce or vinegar. Both herring roe and roe on kelp are extremely salty and have a "strong" almost overpowering taste that is considerably different from most Western tastes. The principal reason for Japanese interest in the Alaska resource is the deteriorating fishery in Japan and the recent fishery concessions given to the USSR after the latter's extension of her territorial limits. Distribution of herring roe products follows the general scheme as described in Chapter IX. The principal outlet for herring roe specialties is through restaurants and small gourmet or specialty shops. However, the Japanese food marketing methods have been changing rapidly to accommodate the supermarket concept, which promises to place more consumers in convenient contact with these specialty foods. There is also a traditional New Year's demand for herring roe, which adds a seasonal element to consumption.

Fortunately, demand for herring sac-roe in Japan has been studied to a limited degree, although the Canadian paper by Frazer and McKay (1976) was never published. Herring roe on kelp demand has not been given any attention, so the only way marketing information can be discussed is by inference, based on what is known of herring sac roe. Frazer and McKay (1976) conclude their demand study by saying that sac roe is an unusual luxury item in that it is relatively inelastic with respect to price. Frazer and McKay assumed a linear demand function, and by their model construction, also assumed negligible effects of population and real income changes. Although the amount of data available did not permit a treatment of these variables, their importance cannot be ignored. The model was of the form:

$$P = a + bQ + e$$

where P = real wholesale price of roe
Q = market clearing quantity of roe
a = 4125
b = 187.6
e = error term with $\mu = 0$ and variance σ^2 assumed

$R^2 = 0.85$; Degrees of Freedom = 3; $t = 4.12$; (t-critical at 95% = 3.182)

Under this model specification, Frazer and McKay state that the optimal amount of herring roe export to Japan is about 11,000 metric tons in total. The 1976 preliminary updates supplied by Canada's Industry Trade and Commerce (Table 68) show a market clearing supply of 11,244 metric tons at ¥ 1,957 per kilo (U.S. $7.06 at ¥ 277/U.S. $1.00). The demand analysis section of Frazer and McKay's paper closes with the following quote:

> The estimated revenue maximizing supply is closely in line with the quantity apparently desired by Japanese trading companies. In discussions with various B.C. industry officials and the Federal Department of Industry, Trade, and Commerce, a figure of 10,000 tons was consistently mentioned as the quantity desired by the Japanese.

However, going back to the original analysis, and looking at the increase in yen value, it may be that the developments in 1977 and 1978 support the view that herring roe is, indeed, a luxury good in the classical sense, despite the apparent seasonal inelastic demand at New Year and effects of population (Table 69). According to the figures on Table 70, compared to market clearing supply on Table 68, a 12 percent carryover in inventory occurred in 1977, ostensibly because consumers were shying away from the high nominal prices of the product. Since herring roe deteriorates markedly in storage beyond one year, it is not likely that this was an intended carryover, but rather a blunder in pricing strategy, brought on mostly by over anxious trading companies. Also supporting this view is the fact that in June 1978, a major herring roe processor, Kimura Kaisan of Hokkaido,

> was declared bankrupt...with unpaid debts reportedly totalling $18 million. Kimura Kaisan...was unable to reduce its huge inventories of unprocessed herring roe in the face of sustained stagnation of the market. The inventories contained expensive imports which the firm had added early last year speculating on a bull market in the post 200-mile era. (NMFS July 1978).

Since 1978, at least one other major processor in Japan has gone bankrupt because of consumer intransigence to high prices of herring roe that was largely brought on by a very poor reading of the world markets by Japanese trading companies. The degree of U.S. and Canada's monopsonistic relationship to Japan is now being felt as the 1980 herring season begins with extremely low exvessel prices being offered.

TABLE 68

MARKET CLEARING SUPPLY AND REAL PRICES
IN YEN PER KILO OF HERRING ROE IN JAPAN

YEAR	MARKET CLEARING SUPPLY (METRIC TONS)	AVERAGE ANNUAL PRICE (YEN/KILO)	JAPANESE CONSUMER PRICE INDEX	REAL PRICE (YEN/KILO)
1971	3,655	4,081	106.1	3,846
1972	8,640	2,356	110.9	2,124
1973	9,593	2,648	123.9	2,137
1974	15,892	2,257	154.2	1,464
1975	9,347	3,828	172.4	2,220
1976	11,244	3,744	188.4	1,987
1977	10,000	4,231	203.6	2,078

Sources: Ishiguro (1978).

TABLE 69

TRENDS IN JAPANESE POPULATION
AND HERRING LANDINGS

Period	Average Catch (Metric Tons)	Population (Millions)	Catch/Capita (Kgs)
1912 to 1916	674,251	52.5	12.8
1917 to 1921	576,996	55.4	10.4
1922 to 1926	516,480	59.2	8.7
1927 to 1931	422,864	63.9	6.6
1932 to 1936	326,567	68.7	4.8
1937 to 1941	126,386	71.4	1.8
1942 to 1946	305,212	72.2	4.2
1947 to 1951	182,666	83.2	2.2
1952 to 1956	162,136	89.3	1.8
1957 to 1961	43,080	93.4	0.4
1962 to 1967	46,497	98.3	0.5
1967 to 1971	82,938	103.7	0.8
1972 to 1976	69,549	109.0	1.3

Source: Ishiguro (1978).

TABLE 70

TOTAL JAPANESE HERRING ROE SUPPLIES, 1970 TO 1977
(In Metric Tons)

Year	Imports	Domestic Supply	Total Supply
1970	1,260	2,403	3,653
1971	1,291	2,364	3,655
1972	8,140	500	8,640
1973	12,093	500	12,593
1974	13,142	500	13,642
1975	8,497	500	8,997
1976	12,289	500	12,789
1977	11,225	500	11,725

Source: Ishiguro (1978).

Several other developments in the world indicate that American herring fishing interests should move with considerable caution, especially with regard to developing long-term fishery commitments with Japan.

In May 1978, at the Trade Fair in Canton, China, overtures were made by China to sell 500 tons of herring roe (about half of the U.S. sales to Japan in 1975) to Japan at prices considerably below the going price for number 1 roe from Canada in Sapporo, Hokkaido (U.S. $10.30 per pound versus $8.37 per pound) (NMFS May 1978). This development was unusual, since for unknown reasons China had made very few sales since 1975.

In August 1978, Japan signed trade agreements with Mainland China. This obviously has been done to attract Japanese technology into the Peoples Republic, but an industry source (Kitano 1978) suggests that such liberalization of trade will probably include the sale of fish to Japan. Japan's trade agreement with the USSR early in 1978 promises to restore the USSR's position as a major supplier of fish to Japan. Both China and the USSR were major suppliers of herring roe prior to 1972.

In September 1977, the Japanese Ministry of International Trade and Industry (MITI) issued input licenses to about 15 Japanese trading firms on an additional 25,000 tons of herring input quota, of which 15,000 tons were Atlantic herring (NMFS October 1977). This report, and others that refer to the same activity on the Atlantic side of Canada, suggest that Canada's Atlantic fishery may offer considerable competition if the roe obtained is of comparable quality.

Consumption of Bait

Although there are no consumption figures for Alaska's bait production, it can easily be inferred that the success of the bait fishery is largely determined by the success of the crab and halibut fishery, which are the two major users of herring bait. Large bait herring however, may be substituted for other baits which are in some cases more desirable. Alternative bait for halibut fishermen are octopus, black cod, salmon tips, and other species called shack bait or gurdy bait which may consist of cods or eels. An alternative bait for crab fishermen may be skate. Table 71 shows a comparison of bait production, crab catch, and halibut catch. It will be noticed for instance, that while the crab fishery has gained in prominence, the halibut fishery has declined. The fluctuations of the bait herring fishery can only be seen in very general terms against the countervailing catches of crab and halibut.

Consumption of Fish Meal

The impact of Alaska herring meals on the U.S. market is small indeed; so small that herring meal is not even listed in the U.S. Department of Commerce's Situation and Outlook Summaries. However, the determinants of demand for meal are well known and apply to herring meal as well as any other types of fish meal. The desirability of fish meal for feed rations is based on the crude protein (percentage weight) that is available for metabolism to the feeder stock. Fish meal, which contains

TABLE 71

YEARLY CRAB CATCH AND BAIT PRODUCTION, 1960 TO 1976
(In Thousands of Pounds)

Year	Crab Catch	U.S. Halibut Catch	Bait
1960	33,303	38,058	4,232
1961	48,011	39,863	3,726
1962	61,783	40,239	6,622
1963	90,824	34,139	4,128
1964	99,444	26,232	4,594
1965	140,566	30,254	4,380
1966	164,256	30,114	5,239
1967	139,432	29,719	6,678
1968	98,532	19,181	4,317
1969	80,241	24,763	5,542
1970	76,230	25,783	6,486
1971	87,332	21,158	4,319
1972	110,010	20,363	5,377
1973	144,966	17,290	10,998
1974	162,938	13,938	12,110
1975	147,520*	16,259	4,532*
1976	73,570*	14,832	3,734*

Source: Alaska Department of Fish and Game Catch and Production Statistics; International Pacific Halibut Commission

*Preliminary

a complementary array of amino acids not found in feed grains, can only be substituted up to a point for corn and soybean meal. However, by far the best indicator of fish meal demand in general is the yearly placement of chicks in feeder operations throughout the United States. Since rations figure so heavily in poultry production, the number of chicks placed on feed is an indicator of the demand that can be expected. Another factor that would determine demand for herring meal would be the prices of all other meals that would be used in the same production processes.

Foreign Trade

Imports

The two major product types of herring that the United States imports from other countries are fresh, chilled, or frozen herring, and herring that are already prepared as specialty food (Tables 72 and 73). It is apparent that Canada is the major supplier of herring in both categories. The prominence of Canada's exports of fresh and frozen herring and smelt is attributable to the large demand that processors in Maine have for herring. Maine processors have had to resort to heavy importation of herring from Canada to maintain full production. Another consistent exporter of fresh and frozen herring to the United States is Portugal. Since there is very little human consumption of raw herring, most of the fresh/frozen herring except that used for bait enter the market as canned fish or as meal and oil. A small quantity of herring are smoked and kippered, used in pet food, or in the by-products market for pearl essence.

A total of 33 countries have exported herring specialty foods of one kind or another to the United States since 1962. The total of herring specialty foods, however, has shown only moderate fluctuation through this time period, and is mainly in response to Canada's activity on the market. European suppliers of these items seem to be more consistent, thereby indicating that these specialty foods are relatively noncompetitive with those herring products produced in the United States. In addition, it is expected that food items such as herring in sauce, canned fried herring, canned, smoked, and kippered herring and pickled items such as roll mops, maatjes herring, bismark herring, and tidbits would have a strong and steady appeal to ethnic groups in the U.S. that would be exhibited as unresponsive consumption behavior in the face of higher prices on imported specialty items brought on by high tariff rates. Practically all of the herring food items produced in the United States are canned, with most of the production occurring in the Northeast, Northcentral, and Midwest United States. Of all herring products entering the United States from other countries, most are used as industrial fish.

TABLE 72

U.S. IMPORTS OF HERRING PRODUCTS PRESERVED BY MEANS OTHER THAN FREEZING OR CHILLING

	Canada		Norway		United Kingdom		Ireland		W. Germany	
	Q	V	Q	V	Q	V	Q	V	Q	V
1962	14,424,396	2,036,894	14,967,142	3,535,492	3,081,451	543,274	510,150	95,939	718,420	230,490
1963	13,949,831	1,977,090	11,604,567	2,146,561	2,448,715	564,428	198,030	34,886	500,738	160,305
1964	12,087,880	1,406,738	8,075,139	1,371,797	1,404,001	253,628	417,540	74,252	5,600	2,839
1965	15,922,041	2,145,428	9,577,379	2,416,397	2,330,549	493,551	456,575	83,352	967,204	312,876
1966	2,756,262	677,303	5,341,319	1,823,185	1,151,432	298,273	...	...	1,295,434	436,866
1967	16,255,042	2,341,706	9,829,318	2,677,500	1,931,428	442,565	42,450	7,494	1,099,983	354,792
1968	18,983,189	2,924,300	6,639,024	1,985,363	1,736,351	395,139	536,355	85,876	1,578,451	490,520
1969	19,406,291	3,231,703	5,970,508	2,201,336	1,589,734	355,946	215,660	50,657	1,579,758	510,575
1970	31,298,871	5,808,991	4,882,161	1,966,131	2,552,479	649,853	156,685	35,428	1,682,398	632,819
1971	30,267,905	6,037,040	3,064,680	1,728,032	1,939,412	559,612	37,675	12,804	1,262,985	554,992
1972	26,385,307	6,251,387	3,075,152	2,010,182	1,927,460	668,659	...	...	1,154,741	623,856
1973	17,927,993	8,430,057	2,755,644	2,361,604	2,056,754	795,563	26,842	27,962	1,782,859	983,751
1974[1]	28,667,603	10,133,000	1,593,291	1,444,000	1,160,042	712,000	...	...	996,049	737,000
1975	30,745,850	11,912,000	859,524	846,000	646,901	430,000	...	...	591,023	431,000
1976	41,588,526	16,415,000	1,007,012	1,137,000	714,406	374,000	...	...	658,282	486,000
1977[2]	28,527,221	13,187,251	836,889	997,489	250,632	181,130	...	...	660,565	544,991

[1]From 1974 to 1977, the Bureau of Census Method of Collecting import data changed, such that most exporting countries could be discerned.
[2]1977 figures are U.S. general imports.

TABLE 72 (Continued)

	Sweden		Spain		Denmark		Finland		Poland	
	Q	V	Q	V	Q	V	Q	V	Q	V
1962	1,228,484	408,246	741,302	134,916	107,843	15,550	4,650	590	900	153
1963	586,104	373,389	344,442	72,927	50,993	6,962	3,000	424	...	...
1964	419,794	97,280	...	...	66,321	9,752	...	...	...	...
1965	1,050,003	408,459	...	...	76,500	16,626	1,738	1,579	4,085	1,567
1966	666,971	329,222	960	531	6,829	1,531	8,429	2,534	...	...
1967	900,509	411,234	2,031	751	48,626	17,744	28,047	8,266	...	...
1968	899,547	438,834	...	...	114,594	26,772	7,200	5,568	...	...
1969	538,569	311,779	1,850	300	100,451	24,566	10,141	6,395	10,000	1,779
1970	265,009	244,492	...	...	32,614	16,916	37,350	23,832	258,208	46,446
1971	467,053	322,744	2,850	643	170,923	50,631	126,746	73,544	...	...
1972	524,848	411,140	...	...	97,872	39,749	102,842	72,509	2,270	471
1973	850,303	646,632	...	...	2,285,938	1,046,628	144,023	94,363	...	...
1974[1]	1,250,859	957,000	...	...	992,006	469,000	172,802	166,000	...	...
1975	354,969	379,000	...	...	...	...	145,490	145,000	...	...
1976	631,019	680,000	...	...	...	...	139,617	180,000	...	...
1977[2]	542,376	662,727	...	...	...	...	119,511	181,587	...	...

TABLE 72 (Continued)

	Iceland		Other		Total		Comments[3]
	Q	V	Q	V	Q	V	
1962	2,797,730	351,567	1,595,365	339,257	40,186,453	7,847,327	1,15,20,2,9,8,3,7,21,10
1963	4,678,280	59,594	1,402,731	340,486	35,762,331	5,737,052	1,20,7,6,2,3,10
1964	5,748,369	802,261	748,486	157,599	28,973,130	4,176,146	1,21,3,10
1965	5,255,680	739,576	982,670	253,520	36,624,424	6,872,931	1,22,2,3
1966	325,697	141,862	253,535	89,065	11,806,868	3,800,372	1,4,2,5,6
1967	4,659,404	759,464	671,434	186,315	35,468,272	7,207,831	1,2,9,7,8,3
1968	1,844,655	408,671	1,476,606	352,762	33,815,972	7,113,805	12,1,8,2,7,9,10,11
1969	1,405,823	456,490	962,069	278,628	31,790,854	7,430,154	1,10,13,7,9,2,14,10
1970	2,531,514	931,711	990,376	347,240	44,687,665	10,703,859	1,2,5,9,15,17,10,16,7,11,3
1971	1,739,227	850,560	811,973	303,130	39,891,429	10,493,732	1,15,9,7,2,17,4,18,10,3
1972	1,523,355	663,939	984,231	408,063	35,778,078	11,149,955	1,15,10,11,7,8,9,5,12,16,3,19
1973	479,053	479,916	959,200	375,808	29,268,609	15,234,284	1,9,10,15,7,16,3
1974[1]	969,644	1,122,000	1,013,211	641,000	36,820,507	16,381,000	22,1
1975	577,615	607,000	786,322	524,000	34,707,694	15,274,000	22,1
1976	131,889	149,000	1,116,778	837,000	45,987,925	20,258,000	22,1
1977[2]	643,476	518,829	764,623	621,890	32,345,293	16,895,894	22,1,7

Source: General Imports and Imports for Consumption, U.S. Bureau of Census.

[3]Countries included in "other" listed in Comments column by a number code as shown below. Entry of the number code in Comments column is in descending order of importance:

1. Netherlands
2. Belgium
3. Hong Kong
4. Taiwan
5. Switzerland
6. India
7. Phillipine Republic
8. France
9. Portugal
10. Japan
11. Austria
12. Republic of South Africa
13. Miquel
14. Venezuela
15. Greece
16. USSR
17. Israel
18. Argentina
19. Nicaragua
20. Italy
21. Iran
22. Unknown

TABLE 73

IMPORTS AND VALUE OF FRESH AND FROZEN SMELTS AND SEA HERRINGS BY COUNTRY AND YEAR

	Canada		Mexico		Brazil		Iceland		Norway	
	Q	V	Q	V	Q	V	Q	V	Q	V
1960	...	...	...	...	...	...	...	...	...	...
1961	...	...	...	...	...	...	...	...	...	...
1962	23,196,074	1,851,576	...	...	...	...	9,722	680	66,000	6,300
1963	13,193,009	954,099	...	...	...	...	...	...	...	...
1964	24,515,002	1,586,765	...	...	...	...	117,783	7,067	...	...
1965	37,581,019	1,823,002	...	...	...	...	238,542	14,313	60,848	5,045
1966	130,683,220	3,240,938	4,056	1,840	24,773	2,128	9,164	550	46,848	4,543
1967	113,538,102	2,821,476	395,493	151,404	...	...	...		15,217	1,280
1968	171,477,928	3,789,539	705,490	262,245	...	...	530,000	5,392	...	...
1969	89,229,788	2,713,414	417,282	107,500	26,650	2,845	21,411,200	192,641	988,548	16,408
1970	93,860,891	2,973,532	109,379	10,806	287,261	35,304	672,000	5,376	168,000	2,226
1971	74,986,182	2,888,679	258,490	41,653	26,915	3,964	...	...	...	...
1972	105,196,782	4,368,076	184,498	21,165	43,050	3,314	...	...	...	...
1973	93,703,752	7,628,569	25,828	11,740	126,275	5,975	...	...	...	...
1974	78,729,704	4,942,000	...	...	...	...	...	...	...	...
1975	90,624,250	7,076,000	...	...	...	...	...	...	...	...
1976	75,332,381	9,089,000	...	...	...	...	...	...	...	...
1977	73,194,158	11,387,136	...	...	...	...	...	...	...	...

TABLE 73 (Continued)

	Netherlands		Portugal		New Zealand/ Australia		Peru	
	Q	V	Q	V	Q	V	Q	V
1960	...	...	...	...	...	...	...	...
1961	...	...	...	...	...	...	...	...
1962	48,222	8,714	83,375	20,110	...	...	...	...
1963	...	...	35,253	8,374	...	...	...	...
1964	120	101	106,489	25,944	...	...	...	...
1965	...	...	61,298	15,636	...	...	...	...
1966	...	...	115,942	30,474	...	...	...	...
1967	...	...	108,894	28,885	...	...	...	...
1968	12,000	4,760	187,567	47,983	...	...	...	...
1969	12,000	4,782	216,487	77,230	...	...	...	...
1970	5,400	1,878	256,438	90,959	31,880	6,376	...	...
1971	...	...	314,536	126,372	...	...	387,091	30,276
1972	...	...	261,610	113,388	...	...	860,984	66,392
1973	23,985	13,835	179,683	78,278	...	...	230,674	17,788
1974	...	...	149,912	83,000	143,980	83,000	...	...
1975	...	...	176,579	93,000	...	...	...	...
1976	...	...	...	...	...	...	...	...
1977	...	...	189,570	93,838	...	...	...	...

TABLE 73 (Continued)

	Italy		Sweden		Other		Total	
	Q	V	Q	V	Q	V	Q	V
1960	...	...	...	...	...	...	...	...
1961	...	...	...	...	...	...	...	...
1962	...	...	...	...	390,886	74,348	23,794,279	1,961,728
1963	...	...	...	...	20,520	2,476	13,248,782	964,949
1964	...	...	3,676	917	31,613	3,878	24,774,683	1,624,672
1965	...	...	...	...	5,650	925	37,947,357	1,858,921
1966	12,160	2,797	...	...	367,440	55,336	131,263,603	3,338,606
1967	...	...	...	...	355,035	35,507	114,412,741	3,038,552
1968	...	...	...	...	240,000	31,324	173,154,785	4,141,243
1969	...	...	40,000	3,604	73,572	4,584	112,415,518	3,123,009
1970	...	...	...	...	...	...	95,391,429	3,126,457
1971	40,000	550	...	...	9,800	2,813	76,023,014	3,094,307
1972	...	...	440	300	7,057	2,856	106,554,421	4,575,401
1973	1,117	967	...	...	306,824	23,860	94,598,138	7,781,012
1974	...	...	...	...	583,828	101,000	79,607,424	5,209,000
1975	...	...	...	...	754,826	218,000	91,555,655	7,387,000
1976	...	...	...	...	639,867	179,000	75,972,248	9,268,000
1977	...	...	...	...	266,959	104,666	73,650,687	11,585,640

Source: United States Bureau of Census Imports for Consumption (1962-1976), and General Imports (1977).

Note: Countries included in "Other" are listed in decending order of their importance by year: 1962- Japan; 1963- Japan; 1964- Republic of South Africa, Barbados, Spain, Japan; 1965- Unknown; 1966- Japan, Republic of South Africa, Pakistan; 1967- Republic of South Africa Spain; 1968- Republic of South Africa; 1969- Spain, Greece, Kuwait; 1970- None Listed; 1971- United Kingdom, Japan, Honduras, Philippines; 1972- Romania, Japan; 1973- Nicaragua, Gabon, Japan Philippines, Ghana, Lebanon; 1974- Unknown; 1975- Unknown, Nicaragua; 1976- Unknown; 1977- Unknown.

Trade Barriers

The tariff system on the import of herring products is, by necessity, very complex (Table 74). One of the factors that determined what rate was charged was the ratio of imports to annual domestic consumption of herring. This ratio reached an all-time high of 62 percent in 1966, according to the Bureau of Census estimates for fresh-chilled and frozen herring, and fell to 45 percent in 1973. This comparatively high ratio is due to the duty-free treatment of sea herring that was provided for the Tariff Act of 1930. The dutiable status has been bound since January 1, 1948, in a concession granted by the United States in the General Agreement on Tariffs and Trade. A good example of the effects of a tariff on imports is the increase in the ratio of imports to consumption in response to the lowering of the ad valorem tariff on herring imports in airtight containers, not in oil. In years before 1968, the ad valorem tariffs for these products are as shown in Table 74. The ratio before 1967, according to the Bureau of Census estimates, was 25 percent. In 1968 and 1969, dramatic responses occurred with the lowering of the tariffs on these items, and ratio rose to 39 percent. A further decrease in the tariffs in 1972 pushed the ratio up again to 39 percent after it had taken a downward turn in 1970 and 1971.

Summary

The herring fishery in Alaska is small compared to the large industries that have evolved around herring in the Atlantic Ocean. However, Europe and Japan suffer from a considerable undersupply of herring products for human consumption. They are likely to be further pressured to seriously consider increasing their imports in the future by the world-wide imposition of resource zone restrictions and EEC bans in the North Sea. Since edible herring and herring products presently find comparatively limited consumer acceptance in the U.S., these products must find an even greater export market in the future for expansion of the fishery to continue.

The Bering Sea herring population has been exploited and researched since the late 1950s by the USSR and Japan. However, a recent Fishery Management Plan for the herring and bottomfish trawl fishery of the Bering Sea authored by the Department of Commerce, has characterized U.S. knowledge on herring populations as poor. The estimated maximum sustainable yield is 50,000 to 100,000 metric tons. The equilibrium yield was 21,000 tons in 1977 with 20,000 tons of the total allowable catch going to foreign fleets, and the U.S. portion was 1,000 metric tons. The resource has been described as overfished in the Eastern Bering Sea. The equilibrium yield was set at 18,750 metric tons in the year 1978 with 10,000 metric tons going to U.S. fishermen and 8,750 to foreign fleets. These developments would indicate that as Japan gets squeezed out of yet another market, she will react in the short run by buying fish products, as has already been her custom. The important question is: Where will she buy?

TABLE 74

TARIFFS ON HERRING PRODUCTS IMPORTED BY THE U.S. FROM PRIOR TO 1968 TO 1976

Product Form	Units	Pre-1968	Effective 01/01/68	Effective 01/01/72	1976
Fresh Chilled or Frozen; Whole or otherwise portioned	Lb	Free	Free	Free	Free
Salted or pickled, whether or not whole but not otherwise prepared or preserved and not in airtight containers					
In bulk or in immediate containers weighing with their containers over 15 pounds each	Lb	.1¢		Free	1¢
Other	Lb	.1¢		6% Ad Val	25% Ad Val
Smoked or kippered, whether or not whole but not otherwise prepared or preserved and not in airtight containers, whole or beheaded but not otherwise processed					
Hard smoked	Lb	.1¢		Free	1.25¢/lb
Other	Lb	.63¢		0.3¢/lb	1.25¢/lb
Otherwise processed	Lb	1.25¢		Free	3¢/lb
In containers weighing with their contents not over 15 pounds each					
In tomato sauce, smoked or kippered and in immediate containers weighing with their contents over 1 pound each	Lb	8% Ad Val	7% Ad Val	4% Ad Val	25% Ad Val
Other	Lb	5% Ad Val	4% Ad Val	Free	25% Ad Val
Other	Lb	1¢/lb.	0.9¢/lb	0.5¢/lb	1.25¢/lb
Prepared or preserved in any manner in oil in airtight containers	Lb	25.5% Ad Val	22.5% Ad Val	12.5% Ad Val	30% Ad Val

SOURCE: U.S. Department of Commerce, Tariff Schedules of the United States, Annotated.

The literature on herring stocks in the Gulf of Alaska reveals a complicated life history of herring, and consequently a confused notion on the condition of herring stocks in the Gulf of Alaska. However, the stocks currently considered to be important, spring herring, have been strictly regulated by the ADF&G based on limited stock assessment data, principally by hydroacoustical techniques. The winter herring fishery supplies bait and high quality fillets; this fishery is under less stringent regulations by ADF&G.

The only domestic market for herring of any consequence to Alaska is the bait fishery. The success of a venture in bait depends ultimately on the buyers of bait and how successful they are. The halibut fishery is not strong: At best, only a moderate amount of bait can be expected to be sold to halibut fishermen. However, tray-pack sport bait and bait for commercial trollers is an important market. The relatively new crab fisheries, on the other hand, are lucrative and fast expanding ventures. The bait fishery for herring appears to have played an important part in their expansion. Competition in the winter bait herring fishery and the fillet markets in a poor year for herring will, for now, result in the crab fishery taking a large share of the herring catch, since the success of a venture in fillet processing is not as certain as in bait.

The dominant herring products in terms of value are the herring roe and roe on kelp, which are sold exclusively to Japan. Both are spring fisheries and in Alaska are extremely small when compared with the British Columbia fishery. The fishery is characterized by a high degree of Japanese involvement in the catching and processing. Canada, because it captures such a large share of the market, tends to inadvertently influence the price for the season over the whole Pacific coast. Some aspects that determine price for a season are the catch of gravid herring, the amount stored and frozen, the quality of the pack (and the name of the technicians in charge of packing), import quotas on whole herring set by the Japanese government via the Hokkaido Fisherman's Cooperative, and competitors such as Mainland China, South Korea, North Korea, Russia, and Canada.

The herring roe on kelp fishery has been active in the Prince William Sound and Bristol Bay areas where the spawn on kelp goes to the Japanese market. The present method of collection of kelp in Alaska has been to hunt and hand pick the leaves as they grow naturally. British Columbia fishermen have had moderate success with artificial propagation of herring roe on kelp in pounds, but are hampered by the inability to determine when the herring are ready to spawn or what parameters to control to get them to spawn. The two different approaches to the fishing of herring roe on kelp has again made the product produced in British Columbia the standard by which other products are measured. It is reported that the British Columbia product is superior to that of other countries, notably China and the Korea, because of more uniform thickness of the egg mass and better overall quality of the product (Johnson 1977). In comparison, only one application for a permit to artificially raise herring roe on kelp was submitted in Cordova, Alaska in 1977, and that was not acted upon by ADF&G.

The herring sac roe fishery in Alaska began in the early 1960s as a result of Japanese interest in salmon roe processing and export to Japan. The Japanese interest in Alaska, of course, was not limited to salmon products. Their interest in world fish resources was the result of a steadily declining fish abundance in their home waters, not the least of which was the decline of the herring resource since 1950. Since 1971, several important developments have occurred. China's export market of herring roe products collapsed in 1975 for unknown reasons, but lately has renewed her interest in trade with Japan not only for herring products, but for other services. The USSR who also was at one time a major roe exporter to Japan has recently shown a renewed interest in expanded trade with Japan. One major Japanese roe processor has gone bankrupt, and the Japanese roe market has shown signs of stagnation due to high nominal prices. The North Atlantic is being eyed by Japan as another, and possibly much larger, source of herring roe.

Production of fillets for European consumption has been considered by some processors, but only two have actually made the investment in the expensive equipment, and only one has gained foreign contacts for further processing and distribution that could be considered permanent. The development in the domestic crab fishery and the sluggish nature of high-priced fillet sales in Europe because of trade strictures and freight rates have heretofore discouraged any further consideration by other Alaska processors. The unfortunate possibility is that Europeans still look on herring as an extremely plentiful commodity and as a consequence, they feel it should be very cheap, as it always has been. The reality of a shrinking herring resource close to home may not hit the European consumer yet and, until it does, Alaskan investors will be wary of entering that market. However, some processors in Alaska hope that the moratorium on herring fishing in the North Sea imposed in 1977 by EEC members will eventually make it profitable to consider increasing export of semi-processed herring products to Europe, and eventually to process the product totally in the U.S. for export to foreign countries. This must be weighed against the possibility that market imports for Alaska herring would not be sufficiently developed by the time the North Sea stocks revive and that an important market could dry up, leaving U.S. investors in a difficult position (Fergeson 1978).

As of now, expansion of the export market to Japan is largely restricted by difficulties in monitoring the herring resource, quotas, and the entry restrictions that are legally imposed on Alaska fishermen and processors. In 1978, for example, Japan reacted with keen interest when Alaska expanded its catch quota of roe herring to 23,000 short tons, according to NMFS (April 1978).

The easing of Japanese import restrictions in 1972 was brought about largely by the dwindling resource in Japan since 1950, and a subsequent closing of the Sea of Okhotsk to the taking of herring. As a consequence, these actions revitalized the herring fishery in Alaska which had been lagging because of the reduced demand for oil and meal ever since the early 1960s. Tighter import quotas on whole herring by the Japanese government could just as easily reduce the importance of Alaska to the point where fishing for sac roe herring for direct export would not be economically feasible to undertake. However, this development seems unlikely since the overall tone of Japanese import policy has been expansive rather than restrictive. A Japanese source translated by NMFS (December 1977) offers this commentary:

> The phenominal increase in imports [in 1977] and the slump in exports are both attributed to the proliferation of the 200-mile economic zones and the rise in value of yen against foreign currencies. Especially after September this year when the value of yen rose sharply, Japan's exports of fishery products reportedly lapsed into either serious slump or virtual standstill.

It might be added, however, that these developments have occurred in the midst of speculative and panic cash buying by the Japanese trading companies foreseeing a strong future market. Price stagnation has apparently set in, and as a result, the roe market appears to behave as though the product is a luxury good in the classical sense. Therefore, it appears that for an economically optimal arrangement, real prices will take a downward trend unless the dollar devalues further. The year of 1980 will likely go down in history as a bleak one for herring fishing.

As long as the yen appreciates against the dollar, members of the American fishing industry will have better chances of turning a respectable profit, provided however, the present scenario is not undermined by the entry of a new seller. However, the days of windfall profits seem to be, at least for now, a thing of the past. In this case it was through no fault of the American fishing fleet or the American processing sector, but a misreading of Japanese demand by Japanese trading companies.

CHAPTER XI

HISTORY OF THE ALASKA SALMON FISHERY

Introduction

The Alaska salmon fishery followed the general path of most fisheries development in Alaska. Bottlenecks in harvesting and processing were systematically eliminated through producers' desire to reach less costly solutions to their production problems. The resource base became physically depleted. Government intervened in the form of fisheries management which imposed harvest limitations, area closures, time closures, and finally gear, area, and time designations. The development of these management alternatives prompts the general observations about the salmon fishery:

1. Exploitation was retarded which gave resource managers a means of "catching up" with industry. Fisheries management, using classical techniques, was not only much slower than industry movement, but very expensive.

2. It was inevitable that the question of social equity would enter the picture. As early as the 1930s (Cooley 1963), the desirability of trading economic efficiency for social equity became apparent: this development was eventually a rallying point for statehood.

The present system of harvest is somewhere between an economically efficient solution and a socially desirable one. Within those constraints that have been set down through history, economic efficiency is still exhibited in the form of capitalization and the introduction of new processing and harvesting techniques and methods.

The development of the salmon fishery involved high level politics. The method of its development as well as who would be the principal benefactors fostered bitter conflict between the canning industries and the territorial government.

The commercial salmon fishery was started, manned, and controlled by interests principally from the states of Washington and California. The Bureau of Fisheries, and later, Fish and Wildlife Service, were hampered many times in their work by inadequate federal funding. As a result, they were forced to rely on information gained from the same industry they sought to control. This led to close relations between the government and private sectors which served to militate against sound management based on biological, social, or long-run economic efficiency criteria for Alaska residents. Historically, the Fish and Wildlife Service had sought to absolve itself from the difficult question of "who should get the fish" by stating their organizational objective as one of biological management of salmon stocks (Crutchfield and Pontecorvo 1969). The issue of salmon trap abolition and absenteeism of most members of the territory's largest industries was a central theme of contention and a point of polarization for the proponents of statehood in Alaska. As a result, the salmon fishery policy adopted by the federal government, with the help of a strong salmon canner's lobby prior to statehood, may be one of the reasons for the isolationist concepts that are common among Alaskans even now.

Since decisions affecting the territory largely originated from Washington, D.C., there appears to have been an imbalance of political power because of a lack of representation. Strong salmon processor lobbies were active in a situation when Alaska residents' only representation was a voteless delegate. This led to situations in which the overwhelming majority of Alaska residents had their minds "made-up" about issues many years before they had the power to impose their will through state rights. An excellent case in point is the question of trap abolition which, when put to a territorial referendum vote in 1948, was nearly six to one in favor of trap abolition. Traps were not abolished until statehood in 1959 (Crutchfield and Pontecorvo 1969).

The many other events that shaped the salmon fishery in Alaska are best discussed in the form of a chronology. Most of the following information was found in Cooley (1963); Crutchfield and Pontecorvo (1969); Cobb and Nathon (1921); deLoach (1939); Pacific Fisherman Yearbooks, 1918 to 1966; and Reports of the Governor of Alaska to the Secretary of Interior, 1885 to 1900.

A Chronology of the Alaska Salmon Fishery

1878 The first two canneries started operations in Alaska.

1884 The first Organic Act for Alaska which provided for a civil government under the auspices of the United States, was formally instituted by the appointment of a territorial governor.

1889 A congressional law forbidding the barricading of streams and rivers was passed.

1892 Funds were made available by the Treasury Department for one inspector and an assistant to enforce the law of 1889. This was largely a token effort.

1893 The Alaska Packers Association, a conglomerate of 22 packing companies, was formed and was operating during this time.

1896 An act of 1896 was passed which limited the places allowed for fishing and the length of nets and traps.

1900 The Secretary of the Treasury promulgated a regulation requiring fishing and processing companies to establish suitable hatcheries. This was largely unenforceable and later rescinded.

1903 A new regulatory agency was created, the Bureau of Fisheries, in the Department of Commerce and Labor, replacing the United States Fish Commission.

1904 The first automatic fish cleaning machine was invented. Dr. David Starr Jordan, biologist at Stanford University, submitted the final report on the Investigation of the Alaska Salmon Fishery to President Theodore Roosevelt.

1906 The Conservation Act was passed which allowed the Secretary of Commerce to extend his sphere of regulation to within 500 yards of the mouths of rivers and streams.

1908 The sanitary can was invented.

1910 Floating fish traps were introduced in Alaska.

1912 The sanitary can was introduced in Alaska.

1914 Industry prevailed upon the Bureau of Fisheries to undertake a worldwide advertising campaign to promote salmon. The Association of Pacific Fisheries was organized.

1916 The 1916 model Iron Chink combination skinner and butcherer, an improvement over the 1904 model, was available to processors.

1917 Self-unloading fish scows were first used. This and other labor saving devices were invented, mostly by individual canners. These vessels had fairly complete machine shops, which were necessary to overcome everyday problems.

1924 The White Act, an expansion of the Conservation Act of 1906, added clauses specifying legal methods of fish catching and fines for non-compliance. This act more specifically defined illegal structures and methods of catching salmon at the mouths of streams.

1929 During 1929 there were 129 canneries in operation, the largest number in history to date.

1933 Cannery labor was organized sufficiently to get the attention of the federal government. The U.S. Government encouraged processors to comply with the spirit of the Re-employment Agreement and Industrial Recovery Act by pledging to improve the wages and conditions of contract labor, and to hire more Alaskans. A new food and drug act was also proposed this year.

1934 The largest pack of salmon since the inception of the fishery was produced in this year.

1940 The Bureau of Fisheries merged with the Bureau of Biological Survey to form the Fish and Wildlife Service.

1948 The Eighteenth Territorial Legislature succeeded in passing a bill providing for a territorial wide referendum on the question of whether traps should be retained or abolished within a 10-year period. In the general election the vote was 19,712 to 2,624 in favor of abolishing traps.

1949 A raw fish tax was imposed, based on the wholesale value of the canned salmon pack. The Territorial Department of Fisheries was created.

1951 Power boats were allowed to fish in Bristol Bay. Up to this time, sail power was the only admissible method of propulsion in Bristol Bay.

1952 The Referendum of 1952 called for the transfer of control of fisheries to the territory. The vote was 20,544 to 3,479 in favor of transferring the control of the fisheries to the territory.

1954 International North Pacific Fisheries Convention was ratified by Japan, Canada, and the United States. Japan agreed to abstrain from fishing east of 175°. This was the beginning of the Japanese high seas salmon fishery.

1955 The power block for purse seines was introduced by Mario Puretic.

1959 Alaska gained statehood. The Alaska Department of Fish and Game as a regulatory agency distinct from the Wildlife Service was formed. Fish traps were eliminated by the Secretary of Interior.

1961 Monofiloment gillnets were outlawed in Alaska.

1964 The earthquake of 1964 damaged major spawning areas. The Japanese began to make purchases of salmon roe from Alaskan processors.

1971 The Alaska state legislature created Fisheries Rehabilitation Enhancement and Development (FRED) Division.

1973 The bill for creating the first comprehensive limited entry program in the United States was signed into law by the Alaska State Legislature.

1974 The Limited Entry Commission began to issue interim-use permits for the 19 salmon fisheries designated for limited entry in 1975, as well as for all commercial fisheries in the state. Catch level was the lowest since the turn of the century. The legislature provided for private nonprofit ownership of hatcheries.

1975 This was the first year of fishing under limited entry.

1976 The United States extended its jurisdiction to 200 miles. The limited entry proposition was upheld by a vote of two to one in the 1976 November general election. The state Supreme Court upheld limited entry laws but ruled out the time limit requiring applicant to have held a license prior to January 1, 1978.

1977 The private hatchery legislation was rewritten to provide for regional planning, administration with input from different interest groups, and financial assistance by the state.

1978 The statewide catch of 1978 was the largest since 1943, when 86.7 million salmon were caught. The 1978 preliminary totals as of November 13, 1978 were 79.389 million salmon. Judge Victor D. Carlson, Superior Court, Anchorage, ruled on December 4, 1978 that the requirement for having held a gear license in order to be eligible to apply for a permit is unconstitutional. This decision is being appealed by Comcercial Fisheries Entry Commission.

1980 The Apokedak case was reversed by the Alaska Supreme Court on February 5, 1980. This case attacks the Commercial Fisheries Entry Commission's point system, which gave gear license holders special consideration over crew members.

CHAPTER XII

THE SALMON RESOURCE

Geographical Distribution

Seven major species commercially called "salmon" are found in the Northern Hemisphere. The one Atlantic species, Salmo salar (the true salmon, similar to a steelhead), has been heavily exploited by nearly all of the European countries adjacent to its range. Its distribution is now largely confined to those countries that imposed the strictest fishing regulations the soonest. The United States, according to the 1976 International North Atlantic Fisheries Commission statistics, did not participate in the Atlantic salmon fishery. However, at one time, the Atlantic salmon had an extreme southern range that extended to the mid-Atlantic seaboard as far as Virginia in North America, into the Northern Mediterranean, and around the boot of Italy in Europe (Netboy 1968). The history of Atlantic salmon exploitation has been thoroughly discussed in a case-by-case manner by Anthony Netboy in his book The Atlantic Salmon.

The other six species are Pacific salmon, all of the genus Oncorhynchus, are found along the Pacific coast of both Asia and North America. Of these six, only one Oncorhynchus masou, is not found in North America. The other five species in order of relative abundance in North America are:

Oncorhynchus gorbuscha (pink salmon)
Oncorhynchus nerka (sockeye salmon)
Oncorhynchus keta (chum salmon)
Oncorhynchus kisutch (coho salmon)
Oncorhynchus tshawytscha (king salmon)

King salmon range from Southern California to Point Hope, Alaska and from Hokkaido, Japan to the Anadyr River in Siberia (McLean et al. 1977, p. 586).

Sockeye salmon range in North America from the Klamath River in California to Point Hope, Alaska; in Asia, this species ranges from Cape Chaplina south, around the Kamchatka Peninsula to the northern shore of the Okhotsk Sea (McLean et al. 1977, p. 590).

Coho salmon in the Americas are distributed from Monterey Bay, California, north to Point Hope, Alaska; in Asia they range from Hokkaido, north to the Anadyr River in Siberia (McLean et al, 1977, p. 595).

Pink salmon range from Northern California into the Arctic Ocean and south again to Hokkaido via the Anadyr River and the Sea of Okhotsk (Mclean et al. 1977, p. 599).

Chum salmon range from California to the Arctic Ocean east to the McKenzie River, and west to the Lena River in Siberia, and south to Pusan, Korea. Their primary range, however, is above 46° north latitude (McLean et al. 1977, p. 604).

Biological Aspects

Atlantic Salmon

The Atlantic salmon is an entirely different genus from many of the other salmonids of the Pacific Coast, but, in fact, is a true salmon and is similar to the steelhead (*Salmo gairdneri*) of the Pacific Coast. This is perhaps the reason that large differences in life histories between the Pacific and Atlantic salmon are apparent. The most obvious difference is that, unlike Pacific salmon, the Atlantic salmon does not necessarily die after spawning. Rare cases have been recorded of *S. salar* spawning as many as four times before dying; there are frequent cases of multiple spawning, but less than four times. The time spent at sea varies from one to five winters with the majority staying at sea two to three winters. The maximum recorded weight of *S. salar* is 106 pounds (Netboy 1968).

Pacific Salmon

Biological characteristics of the five Pacific salmon species are summarized on Table 75 from McLean et al. (1977). Among the things that should be noted is the variability in the times to maturity, sea going phases, and other factors of biological significance. With the exception of the invariable two-year life cycle of the pink salmon, all other Pacific salmon species have a complex life cycle, and the only characteristic that they seem to have in common is the return to fresh water as mature adults. Part of the variability in biological parameters within species may be explained by race; salmon may be racially divided within the species because of isolation caused by geographical, temporal, or climatic barriers. The result is a species that exhibits large variation in growth rates, fecundity, and age to maturity. What this implies is that optimum escapement and sustainable yield estimates would gradually lose their meaning when individual stream and river data are collected and aggregated.

Escapement

The Alaska Department of Fish and Game provides escapement data for each of the 13 management areas in Alaska. The enumeration of escapement, or, the number of spawners that are allowed to return and complete the life cycle, is carried on in a number of ways. These include: direct enumeration from towers, sonar, or counts by foot; aerial surveys, index derived from weir surveys; indices derived from test fishing with gillnet; and estimates derived from streams that are representative of a whole area. Escapement figures are in numbers of fish.

TABLE 75

BIOLOGICAL CHARACTERISTICS OF FIVE PACIFIC SALMON SPECIES

	Average Size and Weight at Maturity	Run	Fecundity (Eggs)	Juveniles Leaves Fresh Water	Sea Going Phase	Maturity
King salmon[1]	40 inches 20 pounds	May to August	3,000 to 14,000 5,000 average	Usually immediately, but may remain for up to 2 yrs. before migrating: latitude dependent	1 to 6 yrs.	2 to 7 yrs. Females usually mature later than males
Sockeye salmon[2]	24 inches 6 to 9 pounds	July to October	2,200 to 4,500 average 3,500 depends on the size of the female	1 to 4 yrs.	1 to 5 yrs.	2 to 7 yrs.
Coho salmon[3]	29 inches 6 to 12 pounds	August to November	2,400 to 5,000	2, 3, or 4 yrs.	1 to 3 yrs.	3 to 7 yrs.
Pink salmon[4]	16 to 22 inches 4 pounds	June to September	1,500 to 2,000	Immediately	15 to 19 mos.	14 to 16 mos. to 2 yrs.
Chum salmon	30 inches 8 pounds	July to September (Some through December)	3,000 average	Immediately	2 to 4 yrs.	3 to 5 yrs.

Source: McLean et al. 1977; Finger 1978.

[1]A 126 pound king salmon was caught in 1949 near Petersburg, Alaska. The residency for fall run juveniles is about 90 days. Spring and summer runs may be 1 to 2 years.
[2]May reach 33 inches in length and weigh up to 15.5 pounds.
[3]Males may return to spawn after only 3 to 6 months at sea.
[4]There is a definite even-odd year difference in stock that sometimes exhibits itself as fluctuation in abundance.

However, the size of Alaska, as well as the diversity of stream types poses serious problems to anyone wanting to arrive at individual stream escapement figures, much less an optimum figure. One of the most difficult problems has been the effective enumeration of escaping fish in turbid rivers and streams. Since 1968, sonar has been effective for providing escapement figures from which optimum escapement may be derived, although species identification must still be done on foot.

Maximum Sustainable Yield

Elaborate theoretical constructs of maximum sustainable yield (MSY) and optimum sustainable yield (OSY) have been fully discussed by members in the fields of economics and life sciences. The assertions made by these scientists accurately describe the dynamics of exploited populations. However, given the equity arguments that have evolved into law, the enormous problem of heterogeneous and time related effort variables and natural variation in populations, empirical forms of yield in equilibrium curves for relevant areas of the state are virtually non-existent. This is not because managers have an ignorance of fisheries theory, but the task simply is unreasonable. The Alaska Department of Fish and Game takes a more realistic stance on the problem of managing for equilibrium yield by using historical averages to arrive at what could be called a "reasonably safe and reversible" level of catch. Estimates of sustainable yield, escapement, optimum escapement, and historical levels of catch for all major areas of Alaska have been formulated by McLean et al. (1977). This is the most comprehensive work yet produced by the Alaska Department of Fish and Game on this topic.

Alaska, U.S., and World Catch Comparisons

Tables 76, 77, and 78 show the world catch by major country, with comparisons between U.S. and world catch and Alaska's contribution to world catch. These figures do not include the major salmon of Japan.

However, from the standpoint of the species that are marketed as "salmon," the tables are quite complete and offer some revealing information about the U.S. and Alaska roles in world fisheries. Table 76 shows the conspicuous absence of the U.S. in the Atlantic salmon fishery; and the conspicuous presence of Canada. This is because Canada has nurtured a harvestable stock. The rest of the world contributors are from the Scandinavian countries, the United Kingdom, and Ireland.

In the total landings of all salmon in the Pacific area (Table 77), the United States has ranged from 21.8 percent of the Pacific catch in 1959 to 44.5 percent in 1970, with an average of 31.7 percent and a standard deviation of 1.3 percent. Canada, by comparison, has caught between 9.4 percent and 23.5 percent of the Pacific catch, with a mean of 15.5 percent and a standard deviation of 0.8 percent over a span of 25 years. Because of the limited U.S. involvement in the Atlantic salmon fishery, the absolute numbers that the U.S. contributes to the total world catch does not change (Table 78), but the relative importance of the U.S. by percentages decreases slightly.

TABLE 76

U.S. AND CANADIAN CATCH OF ATLANTIC SALMON, COMPARED TO WORLD CATCH

Year	U.S. Catch (In Metric Tons)	Canadian Catch (In Thousands of Metric Tons)	World Catch (In Thousands of Metric Tons)
1952	...	3.3	8.6[a,c]
1953	...	4.2	8.8[a,b,c]
1954	...	1.8	6.6[a,b,c]
1955	<50	1.2	5.6[b,c]
1956	<50	1.1	6.2[b,c,]
1957	...	1.2	6.1[a,b,c]
1958	<50	1.6	8.0[b]
1959	<50	1.8	9.0[b]
1960	<50	1.6	8.0[b]
1961	<50	1.6	11.0[b]
1962	<50	1.7	10.0[b]
1963	<50	1.8	13.0[b]
1964	...	2.1	12.0[a,b]
1965	<50	2.2	9.6[b]
1966	<50	2.4	12.3[c]
1967	<50	2.8	14.5[b]
1968	<50	2.1	12.6[b]
1969	<50	2.0	13.2[b]
1970	<50	2.1	12.5[b]
1971	<50	1.8	11.8[b]
1972	<50	1.5	12.1[b]
1973	...	2.2	17.0[a,b]
1974	<0.5	2.2	16.3[a,b]
1975	<0.5	2.2	13.8[a,b]
1976	<0.5	2.2	10.7[a,b]

Source: FAO Yearbook of Fisheries Statistics, various years.

[a] Some data not available

[b] This estimate omits an undetermined amount of catch that was recorded in symbols instead of digits, and may be as large as 100 metric tons in some cases

[c] Includes some smelt and sea trout

TABLE 77

TOTAL LANDINGS OF ALL SALMON IN PACIFIC AREA
SHOWING TOTAL AND PERCENTAGE LANDED
BY U.S. AND CANADA, 1952 TO 1976
(In Thousands of Metric Tons)

Year	Canada Metric Tons	Canada % of Total	United States Metric Tons	United States % of Total	Japan Metric Tons	USSR Metric Tons	Total Metric Tons
1952	68.4	18.2	152.7	40.6	38.5	116.4	376.0
1953	86.3	18.8	139.2	30.3	44.2	188.8	458.5
1954	82.2	19.8	144.1	34.6	78.6	111.0	415.9
1955	60.9	11.5	131.4	24.8	172.5	164.6	529.4
1956	52.9	10.4	142.4	28.0	152.5	160.0	507.8
1957	61.5	12.0	120.6	23.5	184.0	148.0	514.1
1958	83.9	17.6	123.5	25.9	199.0	70.6	477.0
1959	49.6	11.9	90.8	21.8	181.0	94.2	415.6
1960	35.1	9.7	107.4	29.8	148.6	69.5	360.6
1961	56.7	13.0	142.9	32.7	158.3	79.7	437.6
1962	76.0	19.1	142.5	35.8	118.9	60.7	398.1
1963	56.1	13.5	128.9	30.9	150.6	81.1	416.7
1964	58.5	15.2	160.0	41.7	120.0	45.2	383.7
1965	43.1	10.1	149.1	34.8	149.2	87.6	429.0
1966	76.5	17.5	176.4	40.3	128.9	53.6	438.1
1967	62.9	16.1	98.6	25.2	151.4	78.8	391.7
1968	82.6	21.5	149.2	38.9	115.4	36.2	383.4
1969	37.8	10.1	118.5	31.6	143.3	75.4	375.0
1970	72.5	17.4	185.9	44.5	119.8	39.1	417.3
1971	63.1	14.5	151.6	34.9	141.7	30.6	433.9
1972	76.6	23.5	98.2	30.1	118.4	33.1	326.4
1973	86.3	21.9	98.8	25.1	131.9	76.7	393.7
1974	63.4	19.3	88.0	26.5	129.5	48.0	328.1
1975	36.3	9.4	90.0	23.3	155.5	103.0	384.5
1976	57.4	14.8	139.5	35.7	122.4	70.4	389.0

Source: FAO Yearbook of Fisheries Statistics, various years.

TABLE 78

WORLD LANDINGS OF SALMON: PERCENTAGE OF WORLD CATCH TAKEN BY U.S.; PERCENTAGE WORLD CATCH TAKEN BY ALASKA; AND PERCENTAGE U.S. CATCH TAKEN BY ALASKA
(In Thousands of Metric Tons)

Year	World Landings of Atlantic salmon	World Landings of Pacific salmon	Total	U.S. Landings	U.S. % of World	Alaska Landings	Alaska % U.S.	Alaska % World
1952	8.6	376.0	284.6	152.7	39.7	128.4	84.1	33.4
1953	8.8	458.5	467.3	139.2	29.8	99.9	71.8	21.4
1954	6.6	415.9	422.5	144.1	34.1	112.1	77.8	26.5
1955	5.6	529.4	535.0	131.4	24.6	92.4	70.3	17.3
1956	6.2	507.8	514.0	142.4	27.7	122.4	86.0	23.8
1957	6.1	514.1	520.2	120.6	23.3	92.3	76.5	17.7
1958	8.0	477.0	485.0	123.5	25.5	109.4	88.6	22.6
1959	9.0	415.6	424.6	90.8	21.4	66.8	73.6	15.7
1960	8.0	360.6	368.6	107.4	27.8	93.9	87.4	25.5
1961	11.0	437.6	448.6	142.9	31.9	120.1	84.0	26.8
1962	10.0	398.1	408.1	142.5	34.9	126.0	88.4	30.9
1963	13.0	416.7	429.8	128.9	30.0	101.2	78.5	23.6
1964	12.0	383.7	395.7	160.0	40.4	141.3	88.3	35.7
1965	9.6	429.0	438.6	149.1	34.0	124.7	83.6	28.4
1966	12.3	438.1	450.4	176.4	39.2	151.2	85.7	33.6
1967	14.5	391.7	406.2	98.6	24.3	62.8	63.7	15.5
1968	12.6	383.4	396.0	149.2	37.7	129.4	86.7	32.7
1969	13.2	375.0	388.2	118.5	30.5	99.4	83.9	25.6
1970	12.5	417.3	429.8	185.9	43.3	157.2	84.6	36.6
1971	11.8	433.9	445.8	151.6	34.0	114.2	75.3	25.6
1972	12.1	326.4	338.5	98.2	29.0	86.1	87.7	25.4
1973	17.0	393.7	410.7	98.8	24.1	61.9	62.7	15.1
1974	16.3	328.1	344.4	87.1	25.3	59.7	68.5	17.3
1975	13.8	384.5	398.3	89.7	22.5	62.4	69.6	15.7
1976	10.7	389.0	399.7	138.8	34.7	110.7	79.8	27.7

Source: <u>FAO Yearbook of Fisheries Statistics</u>, various years.

The impressive figures, however, are those of Alaska's contribution to the salmon catch of the U.S. and the world (Table 78). In a 25-year span, from 1952 to 1976, Alaska's contribution to U.S. salmon catch ranges from a high of 88.6 percent in 1958 to a low of 60.3 percent in 1955, with a mean of 79.5 percent and a standard error of 1.6 percent. Over the whole world during this same period, Alaska's contribution to world catch ranged from 15.1 percent to 36.6 percent, with a mean of 24.8 percent and a standard error of 1.3 percent. Japan is the only country that leads Alaska in its catch of salmon, with a 25-year mean percent of world catch being 31.5 percent with an associated standard error of 1.7 percent. In this regard, Japan has been Alaska's direct competitor in the North Pacific, and this competition seems to have started in 1955 (Table 77). However, in April of 1977, the tables were turned somewhat when the U.S. declared the 200-mile economic resource zone in effect. A new convention recently ratified by Japan, Canada, and the U.S. will place further constraints on the Japanese salmon fishery west of 175° west longitude (Forrester 1978). Appendix XIII gives a breakdown of salmon catch by species and country, and Appendix XIV shows the percentage of Pacific salmon landed by the U.S. and Canada, by species from 1952 to 1976.

Various federal agencies provided catch statistics for salmon by species and by general areas since the early 1900s, until statehood in 1959. Since statehood, however, the Alaska Department of Fish and Game has collected the salmon catch data for Alaska both by general region (Appendix XV) and smaller management districts (Appendix XVI).

CHAPTER XIII

HARVESTING AND PROCESSING TECHNOLOGY AND MANAGEMENT INNOVATIONS IN THE SALMON FISHERY

The Harvesting Sector

Until statehood in 1959, the salmon fishing industry centered around the use of traps. This highly efficient form of salmon harvest was abolished statewide in 1959 in response to public opinion which had officially called for abolition as early as 1948. The other reason for abolition attempts was to make sure that the statehood charter was quickly ratified (Cooley 1963). The only remaining traps in existence to this date are those that are owned by Metlakatla Indian Reservation in Southeast Alaska. The salmon fishery in Alaska presently allows fishing by handtroll, powertroll, drift gillnet, set gillnet, purse seine, and beach seine. With the exception of the trolling gear, these gear types follow a similar development and have basically the same construction as the herring gear for mesh size. Many of the options for fishing these types of gear are now closed by law, such as the use of monofilament twine in the construction of gillnets or the use of drum seines. However, these general gear types fostered an entirely different relationship between fishermen and processors in the 1970s from that of the turn of the century by making the fishermen more independent. Gear types, size of vessels in different areas, material from which some gear is made, and methods of fishing are regulated by law. This has led to a situation where capital improvements such as better electronic equipment or newer engine or deck layouts, appear more or less extraneous to the actual fishing. Although these improvements may appear extraneous, they represent a rational response to regulatory activity.

The Processing Sector

Until the Alaska oil boom in 1972, the mainstay of the Alaskan economy was fish, and salmon was the main attraction. Canned salmon has been and continues to be the principal product form and a prominant portion of the pack is in one or half-pound cans. However, several changes have come about. Canned salmon of all types has declined slightly in proportion to total salmon production from 88 percent of the total product weight in 1956 to about 75.6 percent of the total product weight in 1976. This decline has been brought about in large part by the increase in the prominence of fresh and frozen salmon. The use of salmon as bait has also increased since 1976. This may have been brought about by some aquaculture organizations in the state needing an outlet for the spent salmon (from which they derive the egg supply) that would otherwise be unmarketable as food in the United States. Also, some cases have arisen where subsistence fishermen would illegally sell salmon caught on their subsistence license to halibut fishermen as bait. However, it is probable that in the future, markets for these spent salmon will be established for use as food.

Probably the most significant change in the processing methods for salmon has been the addition of salmon roe processing lines (Figure 24).

Salmon received by plant, brailed, pewed, or pumped with a water or vacuum medium into totes. Brine holding tanks may be used at this point to hold fish for longer than several hours.

Salmon are then graded by size, species, and condition into: 1) fish suitable for fresh or frozen markets; 2) fish suitable for curing; 3) fish suitable for canning. Usually, king and silver salmon are kept for fresh, frozen, and curing processes, although this is not always the case. In any case, however, only fish in good condition, with no obvious flaws, are taken for fresh/frozen/cured processing.

By-products of the cleaning process are usually converted into meal. Other possible uses for by-products are being created through the invention of flesh extracting units, and the development of markets for milt, livers, and hearts.

CURING PROCESS

Large king and coho salmon; 19 pounds and up.

Fish received and headed, leaving the pectoral girdle on.

Splitter removes the sides, leaving the pectoral girdle on.

Slimer trims and removes blood clots.

Mild Cure:

Brine chilling at 30° - 40°F, salinity of 60 - 70 PPT for up to two hours.

Lightly salted.

Packed in tierces, lightly salted, flesh side up, collar to tail.

Topped with 90% - 100% brine, depending on the temperature.

Cold storage at 22°F for three months or longer.

Hard Cure:

May be whole or split. Placed skin side down in open vats and liberally salted between layers of fish (30 lbs of salt to 100 lbs. of fish) for a minimum of two weeks.

Removed from salting tanks, washed of foreign matter, and graded by color, species, and quality.

Packed 200 lbs to the barrel skin side down and liberally salted.

FRESH/FROZEN PROCESSES

Depending on market conditions, fresh or frozen salmon will be produced. Salmon destined for Japan are usually whole or dressed and frozen. Salmon for use in the United States and Europe may be frozen or fresh, and are usually headed. Fresh salmon, however, is rarely produced in Alaska.

Slimer

ROE PROCESSING:

Workers extract roe.

Soaked in brine one to several days to remove blood residual.

Drained, and agitated in 100% brine solution for 20 minutes or longer.

Graded by cannery personnel under the supervision of Japanese

Functions of the "Iron Chink"

CANNING PROCESS

Heading

Sliming

Finning

Splitting

Gutting

"Bloodline" or kidney removal

Brushing the poke

Carcass goes to the gang knife for portioning into 1 lb., ½ lb., or ¼ lb., sections.

Automatic filler

Automatic salter

Worker checks for proper fill and that the edges of the can are free of fish.

Worker checks for proper fill and that the edges of the can are free of fish.

Topped with 100% brine and stored for use as food or as raw material for smoking.

Smoking: After the salted salmon have been soaked in fresh water from two hours to as long as four days, the product may be cold soaked or hot smoked. Hot smoking is commonly called "kippering" if accompanied with a dye. Hot-smoked salmon is cooked as well as smoked, and is therefore perishable. Cold-smoked salmon is hard, dry and glazed with a thin film of oil and keeps for a reasonable period of time under proper care.

Placed on trays, spaced. These trays are then stacked onto holder and rolled into the freezer.

Blast-frozen at about 40°F for at least 12 hours.

Dipped several times in glazing solution held at just above 32°F. This glazing solution may be water or a solution of water and fructose.

Stored on site or shipped directly to Seattle.

technicians into three categories, d ing o . colo ure, and maturity. Roe in order of desirability by species is ranked in the following manner: chum, coho, reds, kings, and pinks.

Packed in polyethelene lined wood boxes in net weights of about 22 lbs., and salted liberally.

The roe is allowed to cure for several days tightly covered at room temperature.

Boxes are sealed before being sent to Japan by refrigerated transport.

Automatic weighing and shunt for filled

Workers fill cans to correct weight.

Can Size	Fill Weight
No. 1 Tall	16.6 Ounces
No. 1 Flat	16.2 Ounces
No. ½ Flat	8.0 Ounces
No. ¼ Flat	3.9 Ounces
No. 1 Oval	16.0 Ounces
No. ½ Oval	7.9 Ounces
No. ¼ Oval	3.9 Ounces
602 x 403	64.0 Ounces

Tops placed automatically and vacuum sealed.

Retort cases loaded.

Retort

Can Size	Time, Minutes	Temp. F.
No. 1 Tall	90	240-245
No. 1 Flat	90	240-245
No. ½ Flat	80	240-245
No. ¼ Flat	70	240-245
No. 1 Oval	90	240-245
No. ½ Oval	80	240-245
No. ¼ Oval	70	240-245
602 x 403	195	242

Cooling bath

Warehouse cooling

Palletizing and boxing of cans.

Sheathed in plastic wrap.

Stored on site or shipped by carrier (usually barge) to Seattle for storage.

FIGURE 24. SALMON FISHERIES PROCESSING FLOW CHART

These lines seem as simple as the freezing line, and, although labor intensive, involve little specialized equipment. With regard to the method of quality control and the present arrangements between buyer and seller, the salmon roe processing is essentially the same as herring roe processing. A trained technician, usually Japanese, performs organoleptic as well as qualitative and quantitative tests to determine the overall grade of the roe received by the processing plant. This arrangement has not gone unchallenged by some processors and labor leaders, each for their own reasons. Some processors feel that they are able to make the quality control decisions, and perhaps do them better, than the technicians that are supplied to them.

Mobile freezing capacity in the form of refrigerated transport trailers is making a significant impact on the processing community. Problems with undercapacity during heavy parts of the season can be alleviated by leasing these units, and long-term investment in fixed capital equipment is not required. In an operation such as the salmon processing business in which the resource abundance fluctuates due to factors that are largely unknown, this usable capacity is an important addition to the capabilities of a plant. Other "capacity assistance" is available in the form of brine holding tanks. In the event of a glut in the processing line, fish can be held for several days before processing.

Air transport of dressed fish to areas of greater capacity is becoming an increasingly important source of revenue to commercial air operators in Alaska, largely because of the remoteness of the plants in the western part of the state. In addition, tenders and floater-processors play an important role in decreasing the limitations of undercapacity of fixed plants in remote areas during years of exceptionally large runs. The general trend appears to be increased capacity through increased mobility.

Processing Methods

Figure 24 describes all of the major processing methods for salmon found in Alaska. Although situations where all processes are performed at one plant in Alaska are rare, Figure 24 gives a comprehensive view of most operations. It should be noted that the primary functions of most plants based in Alaska are:

1. To provide a point of purchase for the raw product;

2. To perform initial processing to an extent which will allow the product to be traded over time and space;

3. To aggregate the product in sufficient bulk to take advantage of low cost transportation to the rest of the United States and, recently, to Japan.

The reasons for this division of effort may be the costs of holding inventory and of doing secondary processing in Alaska rather than performing the same tasks in the states.

On-Board Handling

The first level of aggregation may take place aboard a tender. The tender holds a unique position in that it extends a number of services to the fishermen besides buying fish. The advantage of the tender activity in the salmon fishery is that it frees the fishermen from having to make for port every time a haul of fish needs to be offloaded. In the salmon fishery, when the boats are restricted in size this service becomes especially important. Tenders may be much larger than the fishing vessels and are either independent or are connected with one or several processing companies. They are equipped with weighing apparatus and different types of refrigeration devices from crushed ice to refrigerated seawater. The tender frequently operates as a "runner" to provide the fishermen with groceries and gear, as space permits. Some fishermen land their catch directly to the processor.

Plant Planning and Handling of Salmon

Processors usually know ahead of time what species the major portion of the catch will be. This is determined by the time of the season, the opening and closing dates set by the Department of Fish and Game, and the management area. Early in the summer, for instance, plants expect a high proportion of reds and kings. Later in the season chums, pinks, and silvers become the dominant catch. Production planning must revolve around the expected catch since each species has, a "best use." Processing activities can be carried on concurrently. Within this context, the Alaska Department of Fish and Game plays a major role in providing indicators to processors on how well the fixed capacity of any one area might accommodate the expected catch in that area.

When the salmon are received at the processing plant, the first problem encountered is how to get the fish out of the boat without excessive damage--a serious problem in the past. Different types of equipment have been used, including fish elevators, buckets from a hoist, and the pugh. The pugh is a single tined fork that is used to impale the fish, load them into a net, which is gathered and brought from the hold to the grading table. The fish may even be pughed at the grading table and finally enter a tote destined for the Iron Chink or the splitter. By the time a fish has reached this stage, however, it has at least one hole in it which devalues the fish, for dressed fresh/frozen head-on trade.

Some other methods to alleviate mutilation caused by handling which have been tried are: fish elevators, suction apparatus pioneered by the Canadians, containerized holds, and trays which can be brought directly up from the hold with a minimum of handling.

Product Types

A number of changes have occurred in the industry since 1956. One of these changes has been the dramatic increase in the production of fresh salmon. Another has been the reduction in the prominence of the mild cure business, and an increase in the amount of smoked products originating from Alaska. However, since mild and hard cure are steps in the production of smoked salmon, what may be occurring is the gradual increase in Alaska's involvement in smoked products, with the salting process being one operation in a line. It almost goes without saying that the growth of the salmon roe business has been extremely rapid. The major processes are discussed below.

Salmon roe. Processing salmon roe in North American packing houses is only the first step toward the final product as it is sold in Japan (Figure 24). Grading the roe is carried out not only on the basis of visual appeal but also on the basis of taste and smell. There are also some tests to determine the chemical makeup of the roe at the time the fish was taken. The roe that is usually prepared in Alaska for the Japanese customer is "Sujiko" style, (Tanikawa 1971), or, the whole roe, including the connective tissue around the egg mass. The brining processes (Figure 24) serve a dual purpose of removing or drawing blood residual from the egg mass as well as seasoning and beginning the dehydration process. Several days of curing will then take place at room temperature before it is sent to Japan. Once in Japan, the roe is likely to follow the same path through the marketing channels as herring roe. This means that the roe will be regraded, repacked, and perhaps even salted further before going to the first wholesale market.

Curing process. The first step in the curing process is the salting of the salmon side either by a hard cure process (dry salting) or a mild cure process (brining). These processes are described in Figure 24. The resulting product may be further processed to produce a kippered (hot smoked) or a cold smoked product.

Canning. The most complex salmon processing method is canning (Figure 24) and as previously discussed, has a fascinating history behind it. Several of the authors that have written on various historical aspects of the salmon canning industry are Cobb and Nathon (1921), de Loach (1939), and Jensen (1976).

The modern canning line is an example of a historical tendency to substitute capital for labor. Prior to the introduction of the sanitary can in 1908, the labor involved in soldering cans from flat pieces of tin called for a production line completely apart from the actual canning process. Can failure was high relative to what it is today. The major improvement in the salmon canning line was the "Iron Chink" (an automatic butchering machine) which replaced much of the oriental labor that had traditionally been used in the butchering lines. Other improvements in the canning line were the switch from top loaded to side loaded retorts, automatic salting and filling machines, and methods of hermetically sealing cans without first cooking the material. The modern salmon canning operation bears little resemblance to methods prior to the turn of the century, mainly as a result of less labor and more capital. Despite this, canned salmon is less important in the fishery than in previous years because of a sluggish stateside market for canned salmon and a great Japanese demand for frozen whole salmon.

Fresh/frozen. Any of the five species of salmon can be processed as fresh/frozen stock. The processes are described in Figure 24. King and coho, and to a certain degree red salmon, are highly regarded by American, European, and Oriental tastes--pinks and chums less so. Although in the 1978 season a significant amount of all five salmon species were processed as fresh/frozen whole in large numbers for Japanese buyers. In 1976, the proportion of canned salmon to all other product forms was about 75 percent. Preliminary estimates of ADF&G suggest that only about 61 percent of the large salmon pack of 1978, imports included, was canned. Most of this frozen fish is sold to Japan.

The Japanese market wants whole frozen salmon with the heads on. Special care is required to keep the whole fish in prime condition for this market.

Harvesting Capacity

In the salmon fishery, as in many of the older fisheries, preventing harvesting overcapacity has been a basic problem. Once started, over capacity is longlived and appears to suppress technological improvement. Alleviation of this problem is one of the major goals of the Commercial Fisheries Entry Commission. The Entry Commission, now into its fifth year of operation, has stabilized the number of permits in the fishery at a maximum and is searching for a method by which an optimum number of permits may be granted. In some cases the maximum number of permits has been exceeded because of hardship qualifying criteria and/or successful applicants as a result of Isakson vs. Rikey (Martin 1978). In the meantime, however, those harvesters who are at least immune to any new influx of permits above the maximum are now at liberty to increase capacity through increases in productive efficiency within the confines of their gear and area limitations. A summary of 1978 harvesting and processing capacities may be found in Appendix XVII.

There are several ways that harvesting capacity might increase. These may become evident in the future and should be recognized. It is likely that for each gear type, there will be a gradual clustering of boat sizes toward the upper end of the legal size limits for boats. The legal limit for boats is 58 feet, but this limit may be revoked for seines in the future (Finger 1979). The long-range results are increased harvest capacity based on physical size of the vessel. It is also likely that, under limited entry, there will be noticeable divisions in markets for limited entry licenses according to gear efficiency and geographic area. This has already happened to some extent. Aside from one-haul capacity measurements, harvesting capacity may be increased seasonally by improved tendering services or lengthened seasons. These possibilities lead to basic questions about the role of production constraints within a framework of limited entry. That is, if there is cause in the future to increase or constrain the harvesting capacity with a management tool, which tool will be the most effective, limited entry or capacity constraint? Some claim, however, that limited entry in and of itself will likely never be sufficient to exclusively manage any resource (Martin 1978).

ADF&G Harvesting Capacity Estimates for 1978

Southeast Alaska. The 1978 harvest range estimate for pink salmon for Southeast Alaska was 12.0 to 24.6 million fish. The average of the harvest range was 18.3 million with other species contributing an additional 2.0 million salmon. ADF&G considered August 1 to August 15 the heaviest part of the season. The peak season harvest in 1978 was estimated to bring out 380 to 390 purse seine vessels: the maximum number of entry permits for Southeast purse seiners was 395. The actual harvest in the Southeast region, as of September 24, 1978, was 18.792 million pink salmon with a total salmon catch of 21.586 million. Both estimates were over the expected catch; 2.69 percent of the pink harvest and 39.70 percent for all other species.

Prince William Sound. The forecast harvest range for pinks in the 1978 season was estimated at 1.618 to 4.778 million fish. The average of the harvest range set 3.198 million fish. The actual pink harvest, as of September 24, 1978, was 2.785 million fish, with a total salmon catch of 3.492 million fish. There are three fisheries in the Prince William Sound Region for which entry permits have been issued. The purse seine fishery has a maximum number of participants set at 238 permit holders. The drift gillnet fishery has 511 permit holders and the set gillnet fishery has 32.

Cook Inlet. ADF&G estimated in June, 1978, that 3.3 million salmon would probably be available for harvest in Cook Inlet. Of this 3.3 million, 700,000 sockeye salmon, 2.0 million pinks and 600,000 chum and coho were expected to comprise the total. The pink harvest rate was estimated at 200,000 salmon per day.

Kodiak. ADF&G estimated a total harvest of 11.4 million pink salmon in the 1978 season. Chum and sockeye harvests were predicted to be 1.4 million for an estimate of between 12.8 to 15.1 million salmon. The maximum anticipated daily harvest was 900,000 salmon, although this figure could be higher. The total harvest in Kodiak, as of September 24, 1978, was 16,200 million fish; 7.28 percent over the highest expected catch. The maximum number of permits in the Kodiak District is 355 for the purse seine fishery, 31 for the beach seine fishery, and 183 for the set gillnet fishery.

Chignik. Totals of 3.0 to 4.4 million salmon for the 1978 season were estimated as the harvest in the Chignik area by ADF&G. At the low end of the harvest it was estimated that about 1.97 million of this total would be pinks and the sockeye salmon harvest would be about 1.07 million. The actual harvest for the 1978 preliminary figures was 1.534 million sockeye and 945,500 pinks. The total salmon catch was 2.608 million, 13 percent less than the expected minimum. The purse seine fishery, which is the only fishery in the Chignik area, has a maximum permit number of 80. The peak harvest was not expected to exceed 85,000 salmon per day.

Alaska Peninsula. ADF&G 1978 pre-season forecast for pink and sockeye harvest was projected at 3.6 million, with pink salmon contributing to the bulk of the catch at 3.2 million. The peak harvest rate was anticipated at 300,000 fish per day, which would be likely to occur during the peak of the pink and chum salmon fishing. The bottleneck in production was anticipated to be in the processing sector. The present maximum number of entry permits (as of 1/21/78) is: 111 for the purse seine fishery; 155 for the drift gillnet fishery; and 77 for the set gillnet fishery.

Bristol Bay. The harvest in Bristol Bay was projected for 1978 to be 8.7 million salmon within a range of 3.8 to 15.1 million. The peak harvest rate in the short term was projected at 1.5 million fish during the first two weeks of July. The actual Bristol Bay harvest was 15.982 million fish, nearly six percent over the maximum projected harvest. In the Bristol Bay area, the following gear permits have been set at a maximum: 1,669 permits for drift gillnet fishery; and 803 permits for set gillnet fishery.

Because of the large diversity of institutions in existence that seek to manage different aspects of the fishery, and because of the nature of fisheries in general, it is difficult to point to any one sector and suggest that there lies the reason for excess (or under) capacity. It is also difficult to provide an easy solution to capacity problems, where no one comes out the loser since the basic problem is to coordinate capacities (carrying capacity with harvest capacity; harvest capacity with processing capacity; processing capacity with storage capacity; and finally with consumer demand). At least one point must be considered (especially in the western part of Alaska): Are the production bottlenecks that have been experienced by the industry in 1978 the result of a positive upswing in the salmon stocks as a result of a number of events that have recently taken place with the help of resource managers, or was the good year of 1978 a freak occurrence? If production bottlenecks have been caused by a strengthening of the resource, perhaps processing capacity should be expanded to meet the increased catches. With respect to the processing capacity shortages in some areas of Alaska, there was indeed "overcapacity" in harvesting in the 1978 season. Capacity expansion or contraction is to some degree linked to information transfer from public resource management to private production and marketing management as well as formation of regulations. In this manner, resource management impacts the industry.

Processing Capacity

Theory and Justification

The problem of defining capacity and capacity utilization has been explored by many economists: Kaldor (1935), Chamberlin (1947), Klein (1960), [illegible] (1968), and Georgianna et al. (1977). The basic notion of capacity arises from the relationship between the cost structure of the firm (industry) and the demand for the output. Klein (1960) denoted the term "excess capacity" as the difference between output demanded and the optimal or least-cost output for the firm. An assertion repeatedly cited in earlier works was that excess capacity was caused by the breakdown of one or all of the assumptions of perfect competition. A similar reason may be given for a situation of under-capacity. For a number of reasons, production beyond a point does not occur because of increasing costs of production. Both cases have occurred in the salmon fisheries throughout history. In the salmon fisheries especially, a determination of capacity and percent utilization is important in order to determine whether industry capacity is consistent with the long run harvest objective of management agencies. Since the extent of overcapacity is an indicator of the well-being of the industry, the resulting analyses from capacity studies should be of great interest to the industry.

Although the idea of processing capacity is easily defined and although the mechanisms that lead to excess or undercapacity are intuitively understood by most people, it is exceedingly difficult to come up with numbers, or indexes that describe processing capacity of any industry, let alone the salmon industry. Several reasons for this are evident:

1. Physical constraints of plants, and bottlenecks in production due to engineering design (due to indivisible units in a processing line) are determinents in the estimation of capacity and are hard to obtain.

2. Institutional factors, such as season length and quotas in the case of the salmon fishery, must be taken into account.

3. Labor and/or labor availability, as well as the institutions and customs that constrain the manner in which labor should be used must be defined.

4. A relevant time period must be defined in conjunction with estimates of capacity, such as daily capacity or seasonal capacity.

5. One must discuss whether capacity should be measured during peak production or normal production, for species intensive activity or diversified activity. Each measurement method has advantages and disadvantages.

In short, any measure of capacity should be properly defined. However, when one expands these concepts to a real world situation, a theoretically acceptable investigation becomes onerous, especially in the case of agriculture and fisheries, where the seasonality of both harvesting and processing may lead to idleness in the off-season that is largely unavoidable. These problems have been addressed by Klein and Long (1974) using a "peak to peak" method of measuring capacity. The concept has been modified by Georgianna et al. (1977) to eliminate "false peaks" that would bias capacity measurement. The method used by Georgianna calls for matching of production peaks with a noticeable decrease in exvessel price. This is based on the hypothesis that as plant production approaches capacity, exvessel price will decrease. The notion is interesting from the aspect of fine tuning capacity using a large amount of data collected almost continually over small time intervals. But the difficulty is that:

1. This type of data is not normally available unless the fishery has been well managed in the past. Implementation of such a method would require cooperation of, and reliance on, processors for both production and exvessel prices paid data.

2. Distortion of exvessel price is apparently widespread in fisheries. So the degree of success in Georgianna's method would depend on the degree of distortion in price brought on by mechanisms at work other than the "free market."

It may be better, in some cases, to rely on an intuitive feeling of capacity by processors, which is the approach of Alaska Department of Fish and Game (ADF&G), rather than try to arrive at a solution empirically.

ADF&G Processing Capacity Estimates for 1978

In June of 1978, the Alaska Department of Fish and Game published its first evaluation of available processing capacity through industry interviews. The inventory consisted of 41 commercial processing facilities in six major salmon harvesting areas. Among some of the more interesting findings of ADF&G (1978) were:

1. Freezer storage using mobile refrigerator/trailers limits the projections of long-term processing capacity. However, the use of mobile freezing capacity that is variable in the short run appears to be a valuable tool in slowing investment in fixed freezing capacity in the face of a fluctuating resource.

2. Comparison of daily processing capacities by areas to peak daily harvest rate projections have identified potential capacity deficiencies for Chignik, Alaska Peninsula, and southern Southeast fisheries.

3. The availability of tender capacity was seen as a vital element in supplementing local processing in the Chignik and Southeast areas.

One of the reasons that the ADF&G processing capacity study was initiated was to determine whether or not an imminent need for the use of foreign transport or processing existed: and, if this need did exist, how extensive it would be considering the run and harvest predictions. The results of this survey are summarized below and tabulated in Appendix XVII.

Southeastern Alaska. Eleven commercial canning operators were expected to operate 26 canning lines to process 800,000 salmon per day, approximately 700,000 of these being pink salmon. Using the conversion factor of 4 pounds to generalize this capacity, these canneries expected to can 3.2 million pounds of salmon. Fourteen existing facilities for freezing expected to be able to freeze 1.0 million pounds of salmon per day, or some 600,000 pink salmon per day. An estimated 350,000 fish could be expected to be exported if the need arose. The seasonal processing capacity of Southeast freezing and canning facilities were projected at 21.8 million.

Prince William Sound. The major processors of salmon in Prince William Sound, although not canvassed by ADF&G, were recently contacted about their processing capacity measurements through an OCS Socioeconomic Study of Alaska Coastal Communities. Daily canning capacities for six of the processors showed a total daily canning capacity of .439 million fish and a daily freezing capacity of about 267.5 tons. The catch, as of November 13, 1978, stands at 3.492 million salmon (Appendix XVII).

Cook Inlet. Nineteen canning lines (eight 1-pound, nine 1/2-pound, and three 1/4-pound lines) were expected to operate in the Cook Inlet areas. ADF&G estimated that plants are capable of processing 220,000 salmon per day. Estimates concluded that if fish were continually available throughout a season of six weeks, the Cook Inlet canneries could can 6.6 million salmon.

The export and fresh/frozen capacity for 22 processing plants suggested a daily capacity of 1.5 million pounds or 300,000 salmon per day assuming the average weight of the fish is 5 pounds. A large amount of storage capacity is available to processors in the form of SeaLand units. Total capacity for Cook Inlet is estimated at 500,000 salmon per day (2.5 million pounds at 5 pounds per fish). The plants themselves are able to provide cold storage for 1.2 million salmon (6.5 million pounds at 5 pounds per fish). The seasonal processing capacity was estimated at 7.9 million salmon (39.5 million pounds at 5 pounds per fish) without considering exports.

Kodiak. The eight processing plants and 15 canning lines (eight 1-pound and six 1/2-pound lines and one 4-pound line) expected daily processing capacities of 825,000 salmon (5.36 million pounds at 6.5 pounds per fish). The seasonal canning capacity was estimated at 15.7 million fish (102.05 million pounds at 6.5 pounds per fish). Eight plants with freezing operations were expected to be able to freeze 526,000 pounds or

80,900 salmon. Thus, 2.4 million salmon (15.6 million pounds at 6.5 pounds per fish) were expected to be the processing capacity for the season. The total processing capacity for the season has been estimated at 18.1 million salmon (117.65 million pounds at 6.5 pounds per fish).

Chignik. The one canning operation in Chignik expected to process 60,000 salmon per day or a seasonal operation of 2.2 million salmon, assuming a six week season. Two freezing operations expected to be able to process 9,000 salmon per day. The seasonal potential has, in the past, been a critical aspect of Chignik's capacity. The total potential freezing capacity has been estimated at about 1.8 million salmon. Again without consideration given to export activities on the use of SeaLand units in the short run.

Alaska Peninsula. Two salmon canneries planned to operate in the Alaska Peninsula. Eight lines (three 1-pound, three 1/2-pound, and two 1/4-pound lines) were expected to be in operation. The combined daily canning capacity estimated by ADF&G was 100,000 salmon, over the normal six to eight week period, a seasonal canning capacity of 4.2 million salmon. The frozen and export capacity was augmented in the past by six floating freezer operations. Five floaters planned to freeze in the areas during the season of 1978. The combined freezer capacity of these facilities is 54,000 salmon per day. Thus the seasonal freezing capacity was expected to be 1.4 million salmon, while the actual holding capacity was much less (800,000 salmon). ADF&G projected a daily total capacity of 214,000 salmon. The total seasonal production (freezing and canning) for local operations was set from 5.0 to 5.6 million salmon.

Bristol Bay. The west side of Bristol Bay has 14 lines (seven 1-pound lines, eight 1/2-pound lines and one 1/4-pound line). ADF&G estimated from this data that 21,000 cases per day or 273,000 fish (using a 13 fish per case conversion factor) is a reasonable estimate of capacity. A short term canning capacity for three days (with application of 90 percent efficiency factor) was 737,100 salmon. This estimation is dependent on adequate brine holding facilities. West side seasonal export capacity of fresh/frozen products was estimated at 150,000 salmon, which was based on 1977 season totals plus plant expansion. The combined capacity of the west side, including exports, suggests that a seasonal capacity of 5.4 million fish would be reasonable.

The canning facilities on the east side of Bristol Bay have 26 canning lines (sixteen 1-pound lines and ten 1/2-pound lines) with an estimated daily canning potential of 624,000 salmon. It was expected that 9.4 million salmon could be processed between June 19 and July 21, a 33-day period. Short term capacity is estimated at 1.7 million salmon per three-day period, depending on availability of live holding capacity. Export capacity is estimated to range between 850,000 and 2 million. The fresh/frozen capacity of shore based and floating processors of the east side is estimated at 1.5 million fish. The combined capacity of the east side of Bristol Bay was estimated by ADF&G at 11.75 million salmon, making the total Bristol Bay seasonal capacity in the neighborhood of 18.95 million salmon.

Comparison of Processing Capacity with 1978 Preliminary Catch

Actual catches in numbers of fish are compared to estimated processing capacity in Appendix XVII. With the exception of Cook Inlet, the preliminary catch as of September 10 seems to be remarkably close to the projected processing capacity in the areas studied by ADF&G. The season has been described by both the trade publications and private contacts as "very successful"; with some under-capacity occurring in Southeast Alaska and Bristol Bay, requiring some of the catch to be shipped to Canada or other points out of the state for processing. The success of the season in 1978 and the apparent full use of the fixed capacity, compared to the very poor years of 1973 and 1974, suggests that in years that are substandard to 1978 a problem of over capacity will exist given the existing firms in operation at this time.

Recent turns of events raise some serious questions to prospective entrants into the processing sector or to those who wish to expand their lines:

1. Limited entry laws have fixed the number of boats permitted to fish in areas already described. Assuming that the fishery is indeed on the upswing, one would expect fishermen to increase the efficiency of their vessels. Perhaps, in the future, limitations on harvesting efficiency may even be relaxed. However, the question becomes whether the increases in harvesting efficiency of the fixed participants will, in the future be restricted by the stock abundance. If fleet upgrading is unrestricted by stocks that are truely increasing and not just fluctuating, an expansion in the processing sector may be called for. If the increase that has been experienced can only be attributed to random fluctuation in the abundance of salmon and not to readily identifiable and stable changes (i.e., the extension of the 200 mile limit, the statewide salmon enhancement program, and the limitation of entrants to harvesting sectors) expansion of fixed processing capacity may not be called for and may in fact cause heavy economic loss. The tendency in fisheries is to expand operations after a good season in anticipation of another good year. This may be unwise because few factors that affect salmon abundance are controllable. Until a definite trend in the recovery of the fisheries can be discerned from a random or cyclic fluctuation, the entrepreneur should be content to rely on the excess capacity of his neighbors or create temporary capacity in the form of airlifts and containerized refrigeration units.

2. Limited entry laws do not seem to address adequately the question of how to equitably and constitutionally deal with new entrants beyond broad outlines found in AS 15.43.290-330. Although a court challenge of the permit allocation was an unlikely occurrence in the eyes of some, the potential ramifications were worth considering from an equity standpoint.

Harvesters who legally operate with limited entry permits hold property rights to the fishery and are presently able to transfer this right to another party for considerable sums of money (Table 79). Therefore, any legalization of newcomers in response to legal decisions may devalue these holdings should fishermen wish them to be transferred. Since the entry permit has some of the same characteristics as any other commodity, its value is tied to its own abundance as well as the health of the fishery.

Management Innovations in the Salmon Industry

Besides the technological innovations that tend to affect harvest and processing efficiency in the salmon industry, Alaska also leads the nation in adopting new management concepts. Three of these management concepts-- Limited Entry; Fisheries Rehabilitation, Enhancement, and Development; and Private, Nonprofit Salmon Hatchery Program--deserve special attention within the context of the salmon fishery and are discussed below.

Salmon Enhancement Under Fisheries Rehabilitation, Enhancement and Development (FRED)

Conception and Organization. In 1971, the Alaska State Legislature created the Division of Fisheries Rehabilitation Enhancement and Development (FRED) for the purpose of developing fisheries plans that would facilitate rehabilitation and enhancement of the state's salmon resource (Kaill 1978b) (AS 16.05.092).

The Division of FRED has been charged with the following responsibilities:

1. Developing and maintaining a comprehensive coordinated state plan for the orderly present and longrange rehabilitation enhancement and development of all aspects of the state's fisheries for the perpetual use, benefit, and enjoyment of all citizens and revise and update this plan annually;

2. Encourage investment by private enterprise in the technological development and economic utilization of fisheries resources;

3. Through rehabilitation, enhancement, and development programs, do all things necessary to ensure perpetual and increasing production and use of food resources of Alaska's waters and continental shelf areas;

4. Make a comprehensive annual report to the legislature containing detailed information regarding accomplishments under this section and proposals of plans and activities for the next fiscal year not later than 20 days after the convening of each regular session (Roys 1977).

TABLE 79

AVERAGE PERMIT PRICE FOR THE MAJOR SALMON FISHERIES
1975 TO JULY 1978

	1975	1976	1977	1978
Salmon Purse Seine				
Southeastern	$ 10,633	$ 9,222	$ 16,666	$ 33,000
Prince William Sound	8,000	10,700	29,800	27,488
Cook Inlet		7,500	10,625	31,667
Kodiak	4,751	9,425	17,611	40,000
Chignik				
Alaska Peninsula				16,750
Salmon Beach Seine				
Kodiak			15,000	
Salmon Drift Gillnet				
Southeastern	9,625	10,212	16,261	33,929
Prince William Sound	3,088	4,406	13,750	23,833
Cook Inlet	3,911	5,551	10,832	35,300
Alaska Peninsula		6,333	10,285	14,250
Bristol Bay	1,165	2,536	6,440	22,000
Salmon Set Gillnet				
Yakutat	750	5,000	7,000	10,480
Prince William Sound				
Cook Inlet	2,250	1,818	4,820	8,625
Kodiak	5,380	3,900	6,600	
Alaska Peninsula		6,250	5,150	
Bristol Bay		2,754	2,538	5,893
Salmon Power Troll				
Southeastern	5,403	4,895	8,831	15,652

Note: Blank entries in the table are used where there were not sufficient observations to protect individual confidentiality.

Source: Commercial Fisheries Entry Commission.

Between 1971 and 1977 the FRED division was engaged in the following activities (Roys 1977):

1. Finding a staff and consultants in the various fields of biology and engineering;

2. Monitoring the development of salmon technology in other areas of the world for possible application to Alaska;

3. Testing and refining technology to fit Alaskan environmental parameters and potentials;

4. Constructing fish pass facilities throughout the state;

5. Forming inventory and assessment teams to investigate further enhancement and rehabilitation opportunities as well as opportunities of power development;

6. Laying the groundwork for the development of long-range coordinated rehabilitation and enhancement plan based upon cost efficient technology, the needs of the people, and the emerging private nonprofit hatcheries.

A $29.2 million bond authorization for salmon enhancement was passed in the general election of 1976 (Roys 1977).

Research Activities and Responsibilities. FRED carries on a number of research activities that are all indirectly related to the efficient management of salmon hatcheries. Some of the most important activities include disease identification, prevention, and control; investigating different hatching and rearing strategies for sockeye, coho, and king salmon; and determining acceptable rearing conditions in different areas. Salmon habitat protection and maintenance is also a responsibility of FRED. FRED provides consultation and research assistance to NMFS and the private nonprofit salmon program.

Alaska's Private Nonprofit Hatchery Program

In 1974, in response to a need to establish a vehicle for the realization of enhancement goals, the state legislature passed a statute authorizing the Alaska Department of Fish and Game (ADF&G) to license private non-profit corporations, and in so doing created Alaska's Private Nonprofit Hatchery Program (Kaill 1978a, 1978b). In 1977, the private hatcheries regulations were rewritten to facilitate orderly development of salmon rehabilitation efforts by dividing Alaska into regions and equitable representation among user groups (Kaill 1978b). The first commercial harvest by a private nonprofit hatchery took place during the summer of 1977 (Kaill 1978b). At present there are five production and planning regions (Northern-Southeast, Southern-Southeast, Prince William Sound, Cook Inlet, and Bristol Bay) and four regional associations formed and officially recognized by ADF&G (Kaill 1978a). These are:

1. Northern-Southeast Regional Aquaculture Association, Inc., Sitka

2. Southern-Southeast Regional Aquaculture Association, Inc., Ketchikan

3. Prince William Sound Regional Aquaculture Association, Inc., Cordova

4. Cook Inlet Regional Aquaculture Association, Inc., Soldotna

These qualified associations are able to take advantage of state financial support of $100,000 planning grants with an additional matching grant of up to $100,000 as well as loans up to $3 million for each hatchery development from a $200 million loan fund.

Limited Entry

Possibly the most controversial issue in commercial fishing is whether or not limited entry is needed. It has been demonstrated that, in years where the fishing is exceptionally good, the number of new entrants into that fishery may be sufficiently large to impose economic hardship on long term members of the industry, causing them to lose any benefits that might have accrued to them as long term fishermen. This "dissipation of producer rents" occurs when the cost of entry is so low that no one is restricted from entering. Because of this, fishing in Alaska in some years has bordered on subsistence. Limited entry is a management tool that has been suggested by some economists as a remedy to the chronic overexploitation of a fish resource by many fishermen. The objective of limited entry is to limit the number of firms (fishermen) that can engage in a fishery. This tool, some claim, places more emphasis on management of whole firms, thus allowing those fishermen who do stay in the fishery to work on increasing efficiency of production, given the already existing constraints on gear efficiency and season lengths.

History of the Limited Entry Law. The legislative measure calling for the creation of the Commercial Fisheries Entry Commission, and passed in 1973 by the Alaska State Legislature, was challenged both by initiative and in the courts (Rickey et al. 1976). However, when the question of whether or not to repeal the limited entry laws was placed on the ballot in the November election of 1976, the statewide vote was nearly two-to-one in favor of limited entry. Nearly 62 percent of the registered voters cast ballots in the election; of those, 93.4 percent voted either for or against the limited entry proposition (Rickey and Adasiak 1977). However, the real question is how different sectors in the Alaskan economy were divided with respect to the laws, and on this point it is not apparent from the statistics who voted for what.

Since Alaska passed its limited entry legislation, the state of Washington passed a moratorium on vessel licenses in its salmon fleet and instituted a limitation scheme for its herring fishery. The Commission has in the past received inquiries from the states of Maine, Virginia, Oregon, Washington, and Texas asking how the Alaskan Program was instituted (Rickey et al. 1976). It should be noted, incidentally, that

Alaska's limited entry laws have already influenced the Alaskan economy by blocking the free entry of most fishermen (with the exception of the hand troll fishery in Southeast Alaska) from Washington state who were driven out of the fishery there by the Boldt Decision in 1976.

In December 1974 the Commission began to issue entry permits for 19 salmon fisheries designated for limited entry in 1975 (Table 80). Prior to that, during the summer of 1974, fishing was conducted on what was called an interim-use permit. The fees for these permits varied depending on the productivity of the salmon gear and the ability of the fishermen to pay. The principal factors that were used to decide who would get limited entry permits were:

1. Degree of economic dependence on fishing, including the percentage of income received, availability of alternative occupations, and investment in fishing vessels and gear;

2. Extent of past participation in the fishery and consistency of participation during each year.

Using these guidelines fishermen were ranked by area and fishing gear type on a point system according to the above criteria. The maximum number of permits (Table 80) was set in anticipation of an upper limit of the reasonable sustainable catch in an area in order to reduce the need of "fiddling" with these numbers constantly. The only salmon fishery that is exempt from the limited entry laws is the hand troll fishery.

Structure and Function of Limited Entry. Senate Bill 39, enacted in July 1973, gives the three member Commercial Fisheries Entry Commission broad powers to:

1. Establish administrative areas suitable for regulating and controlling the entry into the commercial fisheries;

2. Establish, for all types of gear, the maximum number of units of gear for each administrative area;

3. Establish qualifications for the issuance of entry permits to gear operators;

4. Issue entry permits to qualified applicants for up to the maximum number of units of gear established for each administrative area;

5. Provide for the transfer and re-issuance of entry permits to qualified transferees;

6. Provide for the transfer and re-issuance of entry permits for alternative types of legal gear in a manner consistent with the act;

7. Issue interim use permits;

8. Administer the collection of annual fees.

TABLE 80

MAXIMUM NUMBER OF ENTRY PERMITS AVAILABLE TO SALMON FISHERIES IN ALASKA, AS OF 1978

Fishery	Maximum Number of Permits	Fishery	Maximum Number of Permits
Southeastern		Bristol Bay	
Purse Seine	395	Drift Gillnet	1,669
Drift Gillnet	453	Set Gillnet	803
Yakutat		Kuskokwim	
Set Gillnet	150	Gillnet	810
Prince William Sound		Kotzebue	
Purse Seine	258	Set Gillnet	214
Drift Gillnet	511		
Set Gillnet	32	Lower Yukon	
Cook Inlet		Gillnet	627
Purse Seine	68	Upper Yukon	
Drift Gillnet	545	Gillnet	99
Set Gillnet	686	Fish Wheel	126
Kodiak		Norton Sound	
Purse Seine	355	Set Gillnet	195
Beach Seine	31		
Set Gillnet	183	Statewide	
Chignik		Power Gurdy Troll	950
Purse Seine	80		
Peninsula - Aleutians			
Purse Seine	111		
Drift Gillnet	155		
Set Gillnet	77		

Source: Amended Alaska State Code 20 AAC 05.320 (amended 1/21/78).

The legislation also gives the commission the power to collect evidence as it sees fit, as long as the manner in which the evidence is collected satisfies the conditions of assuring fair treatment, and that the evidence collected follows established customs of fair conduct. Decisions of the commission are not final and can be challenged and appealed through the court system.

In addition to the attributes already discussed, the limited entry system has many other features:

1. Permits are assigned to a person for a specific gear type in a specific area. Permit holders are required to be present when the gear is being used.

2. Although most forms of transfer are acceptable, a permit may not be awarded in a judgment, or transferred with constraints on its use or powers of repossession. A permit may, however, be sold, given, or bequeathed to one's estate, and can now be mortgaged if the loan is obtained with the State Loan Program.

3. The limited entry model is easily adapted to other fisheries.

4. "Paper licenses" are effectively eliminated; that is, those fishermen who have imposed a burden on managment and other fishermen by being only occassional fishermen tend to be eliminated.

5. Fishermen may hold multiple permits in a number of areas.

6. Aside from license restriction, the only barrier to entry is the payment of the market price. The net present value of a permit depends on many variables. Transactions occur as a result of differences in expectations about the resource, technical or managerial efficiency time preference, life style preferences, and other factors.

7. ADF&G management efforts remain undisturbed and data on recommended sustainable harvests would be used to formulate optimum permit numbers. ADF&G management may be enhanced by the establishment of optimum permit numbers.

8. A limited entry permit may only be retired if the owner fails for two consecutive years to pay the annual renewal fee.

Problems with the Limited Entry Framework. The strongest arguments for limited entry in the salmon fishery are that producer rents will not be dissipated over a large number of fishermen, that present management techniques will provide a good starting framework without a large reorganization of the fishery, and that the only barriers to entry that exist are those that would be expected in any industry. These barriers have a theoretical justification for existing, based on the failure of markets to allocate a common property resource to its most efficient use. This failure of the market system has been partially corrected by assigning property rights. However, the argument runs full circle at this point and leads to some disturbing problems with the limited entry framework.

One difficulty with limited entry is how to determine the optimum number of licenses which are, for purposes of this discussion, "rights to farm" Alaska's coastal waters. The common property problem is still there, but it is severely constrained from expanding. The Commercial Fisheries Entry Commission has suggested that three criteria should be taken into account when determining the optimum number of licenses:

1. Sustainable harvest compared to the capacity of all vessels involved.

2. Acceptable rate of return in the salmon fishing business or the threshold at which most salmon fishermen would leave the fishery in search of other employment.

3. Optimum gear numbers established to minimize economic hardship on the fishermen.

Criteria 1. initially seems to be simple enough; there is no need to have more boats working the resource than is necessary to fully employ all boats and at the same time harvest the targeted sustainable yield. However, the fears of some economists are that limited entry will inevitably lead to accelerated capitalization in the gear and vessels, thereby offsetting the forced exit of other fishermen. The history of the fishery and economic theory would suggest that as long as there is even a remote possibility of a fisherman losing out because of competition from other fishermen, he will feel a need to compete for the resource; and the best way to do that is through large investments in gear and vessel. Thus, the common property problem is reduced in size but is not eliminated.

There are processes whereby the fishery may be reduced in size to offset efficiency gains through capitalization. But this raises a serious equity question which, incidentally was brought up with regard to floating traps back in the early 1900s. Is it to Alaska's advantage to employ the most efficient means of harvest at the expense of widespread employment in the fishery?

Conversely, suppose the health of the fishery improves much faster than expected. Is the institutional mechanism for expanding the number of permits adequately responsive and equitable? Or will fishermen become monopolistic competitors due to the institution of limited entry? When is it equitable to admit new entrants and precisely how will it be done?

Criteria 2. acceptable rate of return, is an even harder concept to pin down. Does this mean that the fisherman should be paid his opportunity cost for being in the fishery? Clearly, the problem in fisheries is not that of people leaving but of people entering, and it is apparent that in the salmon fishery:

1. Opportunity costs may well be great but total benefits of the fisherman's lifestyle may greatly exceed the monetary benefits alone (i.e., doctors and lawyers who want to go "back to nature").

2. The opportunity costs for some fishermen are extremely small if one assumes a statewide accounting stance in 1978. That is, there will be some fishermen who simply will not find alternative employment no matter how low his income goes just because he loves to fish.

However, this could change with almost any large industrial change in Alaska. From a state accounting stance, then, fishermen's opportunity costs would be significantly raised because of alternative employment. Or, does criteria 2. mean that there is some perceived rate of return that is optimal for salmon fishing based on the assumption that the rate of return to fishing ought to be at least that rate which could be obtained in the next best investment? If this is so, what is the next best investment? A reasonable "rate of return" may also be indirectly tied to the activities of the Commercial Fisheries Entry Commission. If the Commission limits permits only to the point where the present sustainable yield is in relation to harvest capacity, fishermen may be forced to capitalize and compete because of external effects. Endeavors involving high capital costs many times demand high rates of return. It is also possible that some fishermen will demand different rates of return depending on whether they have paid for their boats, how old they are, whether or not they have an alternative profession, etc. Criteria 2. of the three is essentially a normative condition that would be very hard to substantiate, and very costly to implement as an easy criteria for making management decisions.

Criteria 3. is reasonable if it is limited to minimizing hardship of the fishermen that were subjected to limited entry at its start, and not to perpetuating the well-being of fishermen at a certain level of income for all time through permit adjustment. Whatever mechanisms of adjusting licenses that may be adopted, they should have some method of adjusting internally, rather than having changes prompted from a federal or state agency. That is, if a method could be devised where entry and exit were carried on solely on the basis of the individual's perception of his chances on the market, then the function of the Commercial Fisheries Entry Commission essentially dissolves to one of being a proctor of funds, a seller of permits, and a buyer to entice less hardy individuals out of the fishery.

Conclusions

It seems a fallacy to claim that limited entry has assigned property rights to the resource; the fact that the problems associated with a common property resource have been solved by this arrangement is a matter of degree. Limited entry does, however, reduce the field of contestants for the common property resource by assigning rights to fish; not rights to the fish. However accepted patterns of behavior concerning location of effort may strengthen the property rights effect. As a result, precisely the same mechanisms are involved under limited entry except that:

1. Dissipation of rents due to further entry is barred from happening.

2. "Over capitalization" must be anticipated and accounted for during the permit adjustment period

3. It is possible to limit the number of fishermen to a point where they may act as monopolistic competitors in the case of abundant resources. Therefore, from the standpoint of maintaining a highly competitive climate in fisheries at the producer level, this development may be undesirable.

Limited entry laws do not specifically address the problem of implementing, in an equitable and constitutional manner, a controlling mechanism for the entry and exit of firms beyond broad outlines presented in AS 16.43.290-330, although the commission itself may have considered schemes in-house. It is true that some legislative guidance is given for revisions of the optimum number of permits. The commission may increase or decrease this optimum number due to: "established long-term change in biological conditions and market conditions in a fishery" (AS 16. 43.300), and defines a general method of buying back permits (AS 16. 43.310).

Other statutes (AS 16.43.330) specifically empower the commission to issue new permits if the optimum number is greater than the number of permits outstanding, and to assure receipt of fair market value for these permits.

However, these guidelines do not help to address the burgeoning problem of what the optimum number of permits actually is. An alternative view of the problem is suggested:

1. Establishment of a before-the-fact optimum number of permits based on opportunity costs or rates of return yields an <u>indeterminate</u> solution. An "optimum" may only be arrived at through the interaction of the market system and the political/legal process. The assumption that one can arrive at a prior figure stems from a failure to realize that each player in the fishery is trying, given personal and institutional constraints, to maximize rates of return. But each person, according to his abilities and resources will invariably realize different rates of return and will also have different opportunity costs.

2. The maximum number of permits allowable by society will be determined by the political/legal process, as well as any ranking scheme.

3. Permit adjustment to a level not known in advance would seem to be best accomplished in a manner that involves minimum agency intervention, maximum public exposure to information on resource conditions and employs methods that are quickly reversible, and that produce changes in the same incremental magnitude and direction as the changes in the resource base.

Recent Developments in Limited Entry

The Commercial Fisheries Entry Commission (CFEC) has come under heavy attack from some dissatisfied fishermen, some members of the legislature, Alaska Legal Services, and the press. Most of the attacks seem to stem from real or perceived inequities in the limited entry system, and appear to have been brought on by the commission's reluctance to acknowledge and address these problems in a timely fashion before extensive litigation took place. It is also apparent that:

1. On certain key issues such as the rating method used by CEFC to determine permit eligibility, legislative vestment of management power to the CFEC was challenged in the courts on grounds of constitutionality.

2. On other key issues, such as a precise description of how a long range and economically equitable adjustment of permits would be implemented, there seems to have been little direction from the legislature, and very little concern by the commission on stating precise objectives, or elaboration on economic technicalities and mechanisms by which limited entry would work.

Three major court cases and one major issue may change the manner in which limited entry is implemented:

The Apokedak Suit. This case attacks the CFEC's point system for giving gear license holders special considerations over crew-members, who should have (according to Don Cloksin, chief counsel for legal services) the same economic dependence and continuous participation status. This suit would have had the potential of opening up licenses to a number of fishermen not previously eligible, had the Alaska Supreme Court upheld the Superior Court decision in favor of Apokedak. As it stands, the State Supreme Court overturned the lower court decision on this case.

The Wassillie Suit. This case contends that the state did not provide enough advance notice or did not adequately inform 162 Bristol Bay Natives of the importance of the limited entry permits. A lower court rejected the claims, but there is general agreement that there should be some provisions for persons who were eligible to obtain permits in 1975, but did not exercise their right to enter at that time. However, there are implications that this may lead to situations where more freedom of entry and exit will lead to a problem of "paper fishermen."

The Lucy Charlie Suit. This case claims that, at the time limited entry was imposed, the Upper Yukon River fishery was not fully developed and, therefore, more permits should be issued. The implications are, here, that some method of permit distribution must be devised which is in some way contingent on a concensus, preferably a tacit one, between managers and fishermen of what "developed" means.

Each one of these suits has attacked some perceived inequity in the limited entry system. In addition to suits, a study of CFEC, funded by the state legislature has been done. The major issue which seems to nag everyone's conscience is that the costs of limited entry permits is extremely high in some areas, and some fishermen in Alaska are unable to avail themselves of enough money to buy; so the sales go to non-residents. This shortcoming is no longer as critical since recent legislation has made it possible to obtain secured bank loans using the permit as collateral. However, it is clear that the transfer costs are a very effective method of limiting entry, and in fact, seems to be one of the things that is actually going as planned. The price information generated by the market is in fact a measure of what the optimum rate of return is in the fishery by area, through time, adjusted for the resource and the state's economy. But it is also clear that further adjustments to the limited entry model are in order to placate the recent rash of public inquiry and dissent.

CHAPTER XIV

MARKETS, PRICES, DEMAND, AND PROJECTIONS FOR SALMON

Market Channels of Alaska Salmon

Introduction

The analysis done by the Department of Agricultural and Resource Economics at Oregon State University in 1978 serves as the most recent and complete source of information on market channels of Alaska salmon. Although the study is titled Socio-Economics of the Idaho, Washington, Oregon, and California Coho and Chinook Salmon Industry, it contains valuable insights on market channels of Alaskan salmon. Discussions of the distribution of salmon must include Alaska because Alaska dominates the U.S. salmon market in both catch and production.

There has been U.S. export trade in salmon since the early 1920s with England, the Orient, the Pacific islands, and South America. In 1977, approximately 20 percent of the total U.S. and Canadian salmon landed was exported. Of the total volume of those salmon that were not canned, approximately 70 percent were exported, showing a tremendous growth in the export of fresh/frozen salmon over canned salmon (ibid. p 28). This growth may result from increased trade with France and Japan. The French seem to have a national taste for smoked salmon. One of the reactions of Japan to the U.S. 200 mile limit extension has been increased purchases of U.S. salmon. The principal buyers of salmon currently are the United Kingdom, France, Japan, and to some extent, Germany and Sweden.

Exports to Other Nations

Japan. Japan's total imports for the year 1977 was a record high of over 36 million pounds (ibid. p 256). The salmon products that sell well to Japan are small sockeye and chum salmon with heads on, and Sujiko style salmon roe. Large Japanese trading firms, as do some of the larger processors who represent themselves, either have offices or close contact in most of the major fishing centers in the Northwest Pacific. Because of their comparable proximity to the fishing areas and the centers of aggregation, there is much more Japanese market influence than European influence. One of the most interesting changes in market channels has been the Japanese shipment of salmon, and other fish products, by processing ships directly to Japan from Alaska (ibid. p 267). Japan, with its wealth of contacts and its highly developed processing and distribution channels of fish products, may actually be in a position to resell a portion of the salmon acquired from Alaska to European countries, thereby competing with American processors for European markets.

France. Although, in the cited study, the processors interviewed in France claimed a preference to Atlantic salmon, all five species of Pacific salmon were regularly used for smoking, suggesting that there is both competition among species and price related substitutions between chinook and coho and the chum, sockeye, and pink salmon (ibid. p. 246). The predominant product form exported to France is fresh/frozen for the purpose of smoking. French importers deal almost exclusively with a supplier. A contract may or may not be struck, but if one is agreed upon, it usually carries an escape clause with regard to availability of catch (ibid. p. 248). True to form, the rise in the French population and the real income growth, as well as a shift to frozen salmon in supermarkets, have changed the way the product is sold.

United Kingdom. The United Kingdom has always been the world's largest importer of canned salmon, principally sockeye salmon. However, because of the previously poor condition of the pound, considerable substitution for sockeye has occurred. The British seem to be very sensitive about price since real income has declined in the past six years (ibid. p. 223). The comparatively limited amounts of fresh frozen salmon for consumption arriving by air freight during these price-conscious times may be the small "silverbright" phase of all five species. The United Kingdom regularly buys not only from the U.S. but also from Japan, the USSR, and Canada.

Domestic Market Channels

The two methods of delivering salmon to the lower states are by truck or barge. Two minor modes of transportation are air freight and rail. Some salmon caught by U.S. fishermen may find its way into the Canadian Rail System, eventually destined for the Boston/New York area or Chicago. More likely, however, is that the barge traffic from Central and Western Alaska or truck traffic from the Southeast will deliver to Seattle, a major secondary aggregation point for salmon products. The close relationships between Canada and the U.S. in the fish trade makes all transactions very muddled.

There are four intermediate distribution centers for salmon in the United States besides Seattle. These are the San Francisco Bay area, Los Angeles, Chicago, and New York.

San Francisco Bay Area. San Francisco is a major center for production, consumption, and export of salmon (ibid. p. 207). Most of the salmon for the Bay Area comes from California, southern Oregon, and Columbia River ports. Alaska and Puget Sound fish reach the area in a frozen form during the off-season (ibid. p. 203).

Los Angeles. The population of this area makes it one of the most important final destinations for salmon. Los Angeles, however, is not a major landing port, nor is it a redistribution/export center for salmon (ibid. p. 209).

Chicago. At one time, Chicago was the Mid-West distribution center of the U.S. and Canada for fish and other agricultural commodities. The products, salmon included, were usually transshipped to other distributors. The increased use of air cargo, however, has lessened the importance of Chicago as a point of transshipment, but the city is still a major consumer and distributor of salmon. The distributors sell to restaurants which prefer chinook and coho salmon in the six-to-ten pound range, but will also purchase silverbright chums (ibid. p. 214).

New York. Salmon distribution and consumption in New York follows the same pattern as in Chicago. Its large population base makes it a final destination for a large volume of salmon from both the U.S. and Canada. It also is a major distribution center. New York wholesalers, who were interviewed, expressed a preference for fresh troll-caught fish, but also buy substantial volumes of net-caught salmon (ibid. p. 215).

Prices

Introduction

Until the 1960s, prices received by producers at the different marketing levels for salmon and salmon products could only be derived by inference. That is, at the exvessel level, average weight prices for Alaska could be obtained by dividing pounds caught by Alaska fishermen (over large areas) by the estimated total value (Table 81). These prices are of limited use for economic analysis because the total value is obtained by area management biologists estimate of weighted average price over the season. In 1973, the National Marine Fisheries Service started a price collection program at the retail level. In this program called Operation Price Watch, a monthly spot price is taken in ten cities to yield an average spot price. Wholesale prices have been collected for selected salmon products since the 1960s, mainly at New York or Seattle pricing points, although Pacific Fisherman has published total landings and value in various forms since 1910.

Exvessel Landed Price

The price differential between species generally reflects the consumer's tastes regarding each species, the uses to which they are put, their abundance as a species, and the method of harvest. King salmon generally has a high dockside price because of its tendency to be bought and sold as "troll caught" to a fresh/frozen/mild cure market. All of these markets demand a quality that will enable the salmon to be readily accepted for consumption in an uncooked state. Coho salmon falls roughly into the same category although they usually sell at a lower price. The interesting relationships, however, are between sockeye, pink, and chum. Originally the total salmon fishery revolved around the canning of salmon, and the "best" canned salmon was red and chinook. In fact, de Loach, author of The Salmon Canning Industry (1939) cites the pink salmon as more popular for exports because of its lower market price and chum salmon of limited importance because of its undesirability for freezing, smoking, and curing.

TABLE 81

AVERAGE ANNUAL LANDED PRICE BY SALMON SPECIES
BY YEAR, 1960-1975
(In Dollars Per Pound)

Year	King	Red	Coho	Pink	Chum	All Species
1960	.28	.21	.23	.13	.08	.16
1961	.26	.18	.18	.10	.08	.13
1962	.31	.21	.21	.14	.08	.15
1963	.34	.22	.17	.12	.09	.14
1964	.32	.23	.17	.11	.07	.13
1965	.28	.22	.25	.10	.08	.18
1966	.32	.21	.23	.14	.11	.16
1967	.27	.22	.26	.11	.10	.18
1968	.34	.26	.26	.14	.13	.17
1969	.33	.25	.28	.15	.13	.19
1970	.44	.25	.30	.13	.12	.20
1971	.39	.26	.25	.16	.14	.20
1972	.37	.31	.43	.18	.18	.24
1973	.88	.43	.76	.32	.39	.44
1974	.75	.69	.68	.35	.38	.50
1975	.76	.45	.60	.32	.34	.40

Source: Alaska Department of Fish and Game, Statistical Leaflets 1960-1975.

Recent exvessel price increases have been dramatic as a result of several developments in the industry. The shock of the poor year in 1974 surely has some effect. But the increased involvement between fishermen's marketing associations and the processing sector at the bargaining table undoubtedly contributes an upward push on price. Price negotiations for the salmon season begin in early spring long before the actual season. Negotiations usually begin by offers and counter-offers between representatives of processing and representatives of fishing. This negotiation process may extend into the salmon season. Another reason for increased exvessel prices is the awareness by fishermen that the salmon roe, especially of chum and red salmon, have an extremely high value on the Japanese market. The exvessel price should reflect this at the producer level. It is ironic to note that now pink salmon provides most of the canning material, and that the lowly chum salmon has, since 1972, commanded a greater than parity price with pink salmon probably as a result of the Japanese interest in buying chum salmon roe and frozen chum salmon.

Wholesale Salmon Roe Prices

Salmon roe is almost in the same class as herring roe--it is very expensive, much sought after as an hors d'oeuvre food, and to the American palate, may vary from a mild oily fish taste to rank and salty. Some prices for chum salmon roe (Sujiko style) by marketing day at the Tokyo wholesale market are shown in Table 82. By the time the salmon roe reaches the wholesale market in a major city like Tokyo, it has already been graded at least once and may have even been repackaged for the market. Nearly all of the salmon roe that goes from Alaska to Japan is whole, or Sujiko style. Most are hard salted; other packs may be in brine. In addition to grades by quality within species, there is also some pricing differentials according to species. Prices would indicate chum and red salmon roe appear to be the most desirable.

Wholesale Prices of Dressed Frozen Salmon

Tables 83 and 84 show monthly wholesale prices for dressed king and silver salmon at New York, as well as the real annual average price obtained by dividing the nominal price by the wholesale price index for meat, poultry, and fish. It is interesting to note, that with the decrease in the catch starting in 1972, the real prices per pound of coho salmon (consistently priced below king salmon) converged somewhat and in 1974 and 1975 real prices of coho salmon were 85 percent of king salmon real prices, up from 71 percent in 1971. Both coho and king salmon real wholesale prices by year reflect the turbulent problems of the early 1970s, already discussed, as well as the boost in prices caused by the entry of Japan as a major buyer in 1973 and 1977.

Canned Salmon Wholesale Prices

Two forms of substitution may occur in the canned salmon market; salmon may be bid away from canning to the fresh/frozen market. The most

TABLE 82

WHOLESALE PRICES OF CHUM SALMON ROE (SUJIKO) IMPORTS
FROM ALASKA AT TOKYO CENTRAL WHOLESALE MARKET
(Dollars/lb. and Yen/dollar)

Date	$U.S./lb	Yen/dollar
1977		
9/12	8.89	266
9/13	8.54	266
9/26	8.89	266
9/27	8.89	266
9/29	8.89	266
10/21	10.10	261
10/25	10.73	250
10/26	10.73	250
11/1	10.73	250
11/7	10.55	250
11/8	10.73	250
11/10	10.73	250
12/3	10.70	242
12/5	10.70	242
12/9	11.26	242
12/10	11.26	242
12/12	10.89-11.26	242
12/13	10.89-11.26	242
12/16	11.26	242
12/20	11.26	242
1978		
2/27	11.60	235
2/28	11.60	235
3/1	10.63-11.60	235
3/2	...	
3/3	11.60	235
3/11	10.25-11.60	235
3/16	10.63-12.57	235
3/17	10.05-1160	235

Date	$U.S./lb	Yen/dollar
1978		
3/18	10.05-10.63	235
3/20	9.88-10.47	230
3/28	12.84-13.43	230
3/29	10.47-12.84	230
3/30	10.47-12.84	230
4/20	15.08	220
4/27	13.42	220
5/11	12.95-13.95	220
5/13	13.95	228
5/17	13.95	228
5/25	11.36-1196	228
5/27	12.95	228
6/24	12.98	210
6/29	14.28-14.50	210
6/30	20.56	210
7/1	20.45	200
7/5	15.90-18.40	200
7/11	15.22-15.90	200
7/17	13.63-14.31	200
7/18	12.95-13.63	200
7/19	13.63	200
7/21	13.18-13.63	200
7/22	12.50-13.18	200
8/1	13.32	191
8/4	13.08	191
8/7	13.32	191
8/8	13.08-13.32	191
8/9	13.08-13.32	191
8/10	13.08-13.32	191
8/17	12.61-13.08	191

TABLE 82 (CONTINUED)

Date	$U.S./lb	Yen/dollar
1978	(Continued)	
8/19	12.37-12.61	191
8/28	13.87-14.11	190
8/29	13.87	190
8/30	13.87	190
9/5	14.35	190
9/13	13.63-14.35	190
9/14	13.15-13.87	190

Source: National Marine Fisheries Service, Foreign Fishery Information Releases (1977 and 1978).

TABLE 83

WHOLESALE PRICES ANNUALLY ADJUSTED BY THE WHOLESALE PRICE INDEX FOR MEAT, POULTRY, AND FISH FOR DRESSED KING SALMON AT NEW YORK PRICING POINTS

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	AVG	YRAVG WPI	WPI[1]
1969	118.8	117.5	117.5	117.5	119.0	119.0	118.0	121.0	124.0	122.0	123.0	125.0	120.2	105.6	113.8
1970	127.5	127.5	128.0	127.5	130.6	131.9	140.0	144.1	143.6	140.0	140.0	136.0	134.7	116.3	115.8
1971	136.0	136.0	130.0	129.0	125.0	121.3	121.9	119.0	118.8	130.0	130.0	129.5	127.2	109.7	116.0
1972	126.0	125.0	125.0	125.0	125.0	125.0	125.0	145.0	146.3	150.0	150.0	150.0	134.8	103.7	130.0
1973	150.0	160.0	162.0	165.0	165.0	165.0	165.0	200.0	210.0	220.0	220.0	220.0	183.5	109.6	167.5
1974	225.0	225.0	225.0	225.0	229.0	200.0	200.0	200.0	185.0	185.0	185.0	185.0	205.8	125.9	163.5
1975	185.0	185.0	185.0	188.0	188.0	188.0	188.4	193.4	216.9	226.8	240.0	241.0	202.1	105.8	191.0
1976	245.0	245.0	250.0	255.0	253.8	265.0	305.0	325.0	329.0	340.0	375.0	375.0	296.9	163.5	181.6
1977	375.0	375.0	375.0	350.0	352.5	360.0	360.0	360.0	360.0	360.0	360.0	360.0	362.3	199.1	182.0
1978	360.0	360.0	360.0	360.0	360.0	...	...	...	...	...	...	...	360.0	171.3	210.2

Source: NMFS Food Fish Market Review and Outlook, Washington, D.C. 1972-1977.

[1]Wholesale Price Index for meat, poultry, and fish.

TABLE 84

WHOLESALE PRICES ANNUALLY ADJUSTED BY THE WHOLESALE PRICE INDEX FOR MEAT, POULTRY, AND FISH FOR DRESSED SILVER SALMON AT NEW YORK PRICING POINTS

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	AVG	YRAVG / WPI	WPI[1]
1969	82.9	87.5	85.0	85.0	85.0	85.0	85.0	89.0	87.9	93.0	95.0	95.0	87.9	77.2	113.8
1970	96.4	97.5	97.5	100.0	98.8	97.5	105.0	107.5	108.3	110.0	110.0	103.2	102.6	88.6	115.8
1971	103.0	100.1	97.5	96.2	83.0	80.0	80.0	80.0	80.0	80.0	97.5	100.0	89.8	77.4	116.0
1972	101.3	104.0	105.0	105.0	105.0	105.5	105.0	107.0	110.0	130.0	130.0	130.0	111.4	85.7	130.0
1973	140.0	140.0	145.0	150.0	150.0	150.0	150.0	150.0	150.0	165.0	165.0	165.0	151.7	90.6	167.5
1974	185.0	185.0	185.0	185.0	180.0	175.0	175.0	175.0	175.0	160.0	160.0	160.0	175.0	107.0	163.5
1975	160.0	160.0	160.0	160.0	160.0	160.0	160.0	162.0	173.8	187.0	200.0	210.0	171.1	89.6	191.0
1976	210.0	210.0	215.0	215.0	215.0	215.0	...	...	250.0	250.0	250.0	250.0	228.0	125.6	181.6
1977	250.0	250.0	250.0	250.0	250.0	250.0	280.0	280.0	280.0	280.0	280.0	280.0	265.0	145.6	182.0
1978	280.0	280.0	280.0	280.0	280.0	...	...	...	...	...	...	...	280.0	133.2	210.2

Source: NMFS Food Fish Market Review and Outlook, Washington, D.C. 1972-1977.

[1] Wholesale Price Index for meat, poultry, and fish.

recent series of events has shown that this trend has been accelerated by the U.S trade position with Japan. Thus, within the constraints of the harvest success of any one year, competition between freezing and canning also exists. It is also possible that canned tuna operates as a substitute for some canned salmon in the retail market, which would make the demand for canned salmon elastic or highly responsive to changes in price. In fact, the recent work by DeVoretz (1979) shows demand models with significant relationships between the prices of canned salmon and tuna.

Both nominal and real wholesale prices for 1974 took a tremendous jump (about 42 percent increase in the sockeye price per case) as a result of the bad year of 1974, which corresponded also with the first season of relaxed wage and price controls by the federal government. In 1975, the price for all three canned species dropped substantially, apparently owing to the economic recession, slightly higher landings, a larger beginning inventory and a smaller quantity of canned exports for the year (Tables 85 and 86). The year 1976 saw a rise in the real prices of all three canned species, although nominal price fell for sockeye and pink salmon and only rose 15 cents per case for chum salmon. In 1977, the total catch had been the highest since 1971, with the highest beginning of year inventory since 1973. This may have served to slightly depress the prices of some species. Record exports are also recorded in 1977 for fresh/frozen salmon (canned salmon's direct competition for raw product) and canned exports were the highest since 1973. This development may have tended to increase the price for some species.

Retail Prices for Canned Salmon

Table 87 shows the ten-city average retail price from 1973 to March, 1978 for pink and red salmon. Not shown is a similar series for chum salmon that was discontinued in 1976. When the price controls were lifted in late 1973, the subsequent increase in price was fairly dramatic. From 1976 through 1978, when the fishery had been recovering from its bad years, fluctuation in retail price appears to be largely abundance dependent, with respect to seasons and export/import/inventory activity.

Consumption and Demand

Consumption

Table 88 describes the total salmon products available for consumption in the United States from 1960 through 1977 in product weights, aggregated over all species of salmon. Inventories of canned salmon prior to 1965 are not available. This may tend to yield a downward bias to pre-1965 consumption figures.

The 18-year mean landings weight from Table 88 is 205 million pounds with a standard error of 44.631 million pounds. With the exception of 1960, 1967, 1969, and 1972 to 1975, landings have been above that mean. The degree to which the landings impact supplies available for consumption in any year affects the first of year inventory and the balance

TABLE 85

YEARLY AVERAGE OF WHOLESALE PRICES FOR FOUR SALMON SPECIES, ANNUALLY ADJUSTED BY THE WHOLESALE PRICE INDEX FOR MEAT, POULTRY, AND FISH[1]

Year	Sockeye Nominal Price	Sockeye Real Price	Pink Nominal Price	Pink Real Price	Chum Nominal Price	Chum Real Price	Chinook Nominal Price	Chinook Real Price	Meat, Poultry, and Fish, Wholesale Price Index
1960									93.1
1961	35.48	39.03	27.97	30.77	25.14	27.66	32.00	35.20	90.9
1962	35.05	37.13	27.38	29.00	24.87	26.35	31.65	33.53	94.4
1963	36.05	40.55	24.04	27.04	20.28	22.81	31.42	35.34	88.9
1964	38.90	44.97	22.03	25.47	19.63	22.69	31.56	36.49	86.5
1965	38.65	40.18	23.40	24.32	19.53	20.30	31.16	32.39	96.2
1966	36.20	34.48	28.33	26.98	24.28	23.12	30.50	29.05	105.0
1967	37.60	37.60	28.92	28.92	25.76	25.76	31.16	31.16	100.0
1968	40.31	39.10	31.99	31.03	28.80	27.93	34.00	32.98	103.1
1969	42.64	37.47	31.28	27.49	27.67	24.31	34.73	30.52	113.8
1970	43.19	37.30	32.65	28.20	28.71	24.79	37.17	32.10	115.8
1971	42.85	36.94	34.86	30.05	30.56	26.34	37.70	32.50	116.0
1972	51.08	39.29	40.01	30.78	34.27	26.36	...	...	130.0
1973	76.74	45.81	54.25	32.39	48.48	28.94	...	...	167.5
1974	109.31	66.86	70.97	43.41	65.45	40.03	...	...	163.5
1975	83.14	43.53	69.65	36.47	59.63	31.22	...	...	191.0
1976	82.78	45.59	68.53	37.74	59.78	32.92	...	...	181.6
1977	88.62	48.69	67.02	36.82	58.99	32.41	...	...	182.0[2]
1978	92.00	43.77	66.00	31.40	57.00	27.12	...	...	210.2[2,3]

Source: Bureau of Commercial Fisheries Food Fish Situation and Outlook 1960-1970. NMFS Food Fish Market Review and Outlook 1971-1978.

[1]Standard 48-pound cases, Seattle pricing points.

[2]Preliminary, subject to revision.

[3]Six-month average.

TABLE 86

AVERAGE WHOLESALE PRICE OF CANNED SALMON
PER CASE IN THE UNITED STATES, 1961 to 1977
(Per Case)[1]

YEAR	AVERAGE WHOLESALE PRICE OF SOCKEYE	AVERAGE WHOLESALE PRICE OF PINKS
1961	$ 35.48	$ 27.97
1962	35.05	27.38
1963	36.05	24.04
1964	38.90	22.03
1965	38.65	24.40
1966	36.20	28.33
1967	35.50[2]	27.50
1968	40.31	31.99
1969	42.64	31.28
1970	43.19	32.65
1971	42.85	34.86
1972	51.08	40.01
1973	76.74	54.25
1974	109.31	70.97
1975	83.14	69.65
1976	82.78	68.53
1977	88.82	67.02

Source: Bureau of Commercial Fisheries <u>Food Fish Situation and Outlook 1961-1970</u>. NMFS <u>Food Fish Market Review and Outlook</u> 1971-1977.

[1]48 1-pound tall cans
[2]January price; not average for the year.

TABLE 87

SOME RETAIL PRICES FOR CANNED SALMON[1]

Pink Salmon

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
1973	...	...	...	1.27	1.30	1.30	1.29	1.39	1.33	1.63	1.92	1.88	1.48
1974	1.95	1.92	1.95	1.87	1.96	1.93	1.99	2.10	2.09	2.00	2.11	...	1.99
1975	2.09	2.01	2.05	2.07	2.04	2.07	2.11	2.08	1.96	2.00	2.00	2.02	2.04
1976	2.02	2.00	2.03	2.03	2.04	2.03	2.02	1.96	1.99	2.00	1.98	2.00	2.01
1977	2.04	1.95	2.08	2.01	2.01	2.00	2.01	2.05	2.07	2.07	2.02	2.01	2.19
1978	2.05	2.03	2.03	...	...	...	...	...	...	...	...	...	2.04

Red Salmon

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Avg.
1973	...	...	...	1.68	1.56	1.81	1.73	1.80	1.99	2.47	2.71	2.86	2.06
1974	3.03	2.84	2.76	2.76	2.79	2.84	2.99	3.04	2.97	3.15	3.04	...	2.93
1975	2.98	2.87	2.83	2.76	2.72	2.68	2.69	2.71	2.52	2.56	2.65	2.53	2.71
1976	2.76	2.72	2.74	2.70	2.91	2.80	2.68	2.57	2.54	2.59	2.50	2.53	2.67
1977	2.57	2.59	2.65	2.64	2.60	2.70	2.70	2.70	2.80	2.79	2.73	2.71	2.68
1978	2.80	2.78	2.83	...	...	...	...	...	...	...	...	...	2.80

Source: NMFS Operation Price Watch, 1978.

[1]Average 10-city price of standard 1-pound tall canned salmon.

TABLE 88

CONSUMPTION OF SALMON PRODUCTS IN THE U.S.
(In Thousands of Pounds)

Year	Landings[1] Dressed Weight lbs.	First of Year[2] Canned Pack Inventory lbs.	First of Year[3] Frozen Inventory lbs.	First of Year[4] Cured Inventory lbs.	Canned[5] Imports lbs.	Fresh/[6] Frozen Imports lbs.	Cured[7] Imports lbs.	Total Available For Consumption lbs.
1960	164,812	...	7,754	4,296	19,113	13,472	56	209,503
1961	217,278	...	9,591	3,200	7,167	12,309	41	249,586
1962	220,196	...	9,120	4,518	6,843	9,735	64	250,476
1963	205,923	...	12,055	4,005	1,250	8,898	135	232,266
1964	246,572	...	10,869	3,964	236	8,818	105	270,564
1965	228,764	160,752	14,283	4,136	101	7,861	130	416,027
1966	271,258	132,528	12,197	4,348	589	8,296	131	429,347
1967	151,664	165,888	12,623	2,701	121	8,815	60	341,872
1968	229,326	100,176	10,412	1,604	4,955	9,811	154	356,438
1969	187,479	131,808	17,320	1,562	2,217	8,425	138	348,949
1970	287,083	103,824	9,777	1,430	2,441	7,448	120	412,123
1971	232,620	127,200	23,682	2,191	1,551	7,684	167	395,095
1972	162,287	129,552	19,457	2,050	11,647	18,696	82	343,771
1973	155,152	72,384	21,120	891	7,859	18,237	107	275,750
1974	137,774	45,168	27,812	967	8,553	12,483	187	232,944
1975	141,113	80,064	24,092	1,216	3,265	9,250	197	259,197
1976	216,469	64,992	17,403	853	2,521	7,742	204	310,184
1977	234,949	98,016	24,756	568	586	5,708	359	364,942

TABLE 88 (CONTINUED)

Year	Ending[2] Inventory of Canned Pack lbs.	Ending[3] Inventory of Frozen Goods lbs.	Ending[4] Inventory of Cured Goods lbs.	Canned Exports lbs.	Fresh/ Frozen Exports lbs.	Apparent Consumption lbs.	Total U.S.[8] Resident Population Numbers	Per Capita[9] Apparent Consumption
1960	...	9,591	3,200	21,264	2,849	172,599	179,979	.9590
1961	...	9,120	4,518	19,584	1,094	215,297	182,992	1.1765
1962	...	12,055	4,005	22,512	1,508	210,396	185,771	1.1326
1963	...	10,869	3,964	8,304	4,888	204,241	188,483	1.0836
1964	...	14,283	4,136	16,944	22,560	212,601	191,141	1.1123
1965	132,528	12,197	4,348	21,360	10,559	235,035	193,526	1.2145
1966	165,888	12,623	2,701	18,240	19,845	210,050	195,576	1.0740
1967	100,176	10,412	1,604	16,800	18,911	193,969	197,457	.9823
1968	131,808	17,320	1,562	15,552	16,234	173,962	199,399	.8724
1969	103,824	9,777	1,430	5,712	30,553	203,107	201,385	1.0086
1970	127,200	23,682	2,191	20,544	28,201	210,305	203,810	1.0319
1971	129,552	19,457	2,050	20,496	32,891	190,649	206,219	.9245
1972	72,384	21,120	891	24,912	34,685	189,779	208,234	.9114
1973	45,168	27,812	967	20,928	60,743	120,132	209,859	.5724
1974	80,064	24,092	1,216	10,224	28,067	89,281	211,389	.4224
1975	64,992	17,403	853	8,976	48,229	118,744	213,051	.5574
1976	98,016	24,756	568	7,200	41,922	137,722	214,669	.6416
1977	124,128	29,165	1,084	11,904	69,844	128,817	216,332	.5955

Source: Fishery Statistics of the U.S.; Current Fisheries Statistics; Bureau of Census

[1]Round weight converted to dressed weight by a factor of .70.
[2]Figures are not available prior to 1965. Number of pounds of canned salmon was determined by applying the conversion of 48 lbs/standard case.
[3]Includes fillets, steaks, round and dressed.
[4]Includes only mild cure salmon.
[5]48 lbs/standard case; includes salmon packed in oil.
[6]Includes fresh and chilled salmon in fillet, steak, and round/dressed form.
[7]Includes dry and brine salted smoked kippered.
[8]Population estimates as of July 1, excluding armed forces overseas.
[9]Figures prior to 1965 are not directly comparable to those after 1965, since canned inventory statistics are only available from 1965 on.

between imports and exports of products. The U.S. is a consistent net exporter of salmon products even in lean years. Over the time span shown, simple correlations between net exports of canned salmon and landed weight revealed that there were no statistically significant relationships either in direct or lagged function forms between the export of canned salmon and the seasonal success in terms of catch. There is also insignificant relationships between first of year inventory of canned salmon and net exports.

Starting in 1972 the salmon catch declined. Consumption reached an all time low in 1974 and 1975: both per capita and total apparent consumption, also went down. The wage and price freeze of 1971 had a tendency to maintain exports at high levels until its removal in late 1973. Throughout the 1960s and 1970s the U.S. resident population was rising at an average rate of 1.09 percent per year (standard error = .2941%). The result is that per capita apparent consumption has been on a general decline (Table 88) due to fluctuations in landings, imports, exports, and increasing population.

Another factor that may be contributing to this decreased consumption is the relationship of canned tuna prices to canned salmon prices. Canned tuna prices at the wholesale level have risen at a consistently lower rate than the prices for all three types of salmon canned in quantity since 1970. The final observation that should be made is that the percentage of the total weight available for consumption that actually was consumed during the year in the U.S. has also declined steadily from 82 percent in 1960 to 35 percent in 1977, reflecting the growing importance of the United States in the export market. Why has this shift in emphasis occurred? The answers are in the following discussions of previous demand analyses in the U.S., Canadian prices, price discovery mechanisms in the U.S. and the U.S. exhange rate in terms of the currencies of the neighboring countries that trade with the United States.

Recent Demand Analysis

A recent study by DeVoretz (1979) reviews the relevant works on salmon demand by Wood (1970), Johnston and Wood (1974), Johnston and Wang (1977), Nash and Bell (1969), Waugh and Norton (1969), Farrell and Lampe (1967), Wang (1976) and Mayo (1978). All of these works have attempted with varying success to mathematically describe what goes on in the salmon industry in Canada and the United States. Although this material is fairly difficult to read through, the advantage of these "econometric" analyses is that one can say, with a reasonable amount of accuracy, the phenomenon that are "normal" for the industry. DeVoretz's conclusions are:

1. It is possible to mathematically describe the consumption of salmon by U.S. and Canada. This is because most data collected by agencies in both the U.S. and Canada are accurate enough to uphold the prevailing hypotheses about the industry.

2. Simple, single equation models estimated from U.S. canned salmon data show that the inverse relation between the wholesale price and quantity is strong for canned pink salmon. There is considerable price elasticity, which means that the change in quantity of canned pink salmon demanded is proportionately larger than the change in the price of the salmon. There is also considerable income elasticity, which means that as real income per capita goes up, consumption of salmon will increase proportionately. However, pink salmon is substituted for other canned fish products (especially tuna) if prices of tuna fall or if prices of pink salmon rise.

3. Simple, single equation models show that there is an inverse relationship between canned sockeye salmon prices in the U.S. and quality demanded. Also, canned sockeye salmon is very price elastic. Sockeye does not tend to be substituted for other products in the face of higher sockeye prices as much as the pink salmon, neither is the income effect as great as for pink salmon. This is to say that DeVoretz's estimations suggest that sockeye sales are somewhat less susceptable to changes in real income.

4. In the United States there seems to be no significant relationship between the quantity of canned chum and its price. However, there is an inverse relationship between the quantity of pinks landed and the price of canned chum salmon.

5. The U.S. fresh/frozen market cannot be separated by species. Simple, single equation models describing the quantity of salmon demanded as a function of the price did not yield significant results. However, when canned pink salmon prices were substituted in lieu of the composite price index (based on the argument that a substitute for frozen salmon steaks would be canned salmon), this yielded a believable model with significant variables. The price elasticity was generally less than that for pink and sockeye, signifying that changes in quantity demanded are proportionately less than the two other salmon species given a unitary change in price. However, the price elasticity with regard to the demand for frozen salmon steak was still greater than unity, signifying an elastic demand.

6. Canadian single equation models derived for the wholesale canned market perform well for all species. These yield similar results to the U.S. single equation models. The principal observation that was expected is that Canadian markets are elastic with respect to our prices and per capita income changes. However, the preliminary descriptions of the fresh/frozen market using the single equations did not perform well.

7. Canned tuna in the United States seems to be drawing consumers away from canned salmon. Although this cannot be conclusively established using the DeVoretz study, a strong case for it has been made by Johnston and Wang (1977) and Johnston and Wood (1974). It is also suspected that canned pink and sockeye salmon are price leaders in the canned salmon industry.

8. When the demand and supply of salmon were accounted for simultaneously, nearly all of the estimates of price and income elasticity were conservative, indicating that the simple equations overstated the elasticity of the salmon markets.

9. Demand for the United States is best described by equations where price is a function of quantity. This description was derived from existing data. The Canadian market has supply and demand interactions for which the quantity supplied of a particular species product type responds to changes in the wholesale price as well as the quantity demanded (DeVoretz 1979).

There were many other conclusions that can be drawn with regard to salmon demand both in the United States and Canada. However, a complete discussion of them would go beyond the scope of this work, since it involves the discussion of mathematical and statistical nuances peculiar to demand equations. References have been provided for further study.

World Trade of Salmon Products

Japan, Canada, the United States, and the USSR comprise the major producers of frozen and canned salmon for the world (Appendix XVIII). In 1976, for example, the United States led the world in exports of frozen salmon, with Canada close behind. In that same year, the U.S. captured 22.1 percent of the total export market for canned salmon with Japan leading at 46 percent of the total exports. As would be expected, there are a number of factors that affect the world trade for salmon. The complexity of these problems is compounded by the fact that each major producer is not only a competitor on the world market but in some cases a "guest" in the waters of the other competitors, partaking of the resource through international agreements. This has led to some interesting transfers of advantage in the wake of the new International North Pacific Fisheries Agreements and the extension of the territorial limits to 200 miles by all countries involved in taking salmon. However, these two events, although of great importance, explain fluctuation in world trade only since 1976.

The 1970 U.S. salmon catch was large for an even year. The Canadian catch of 72.5 metric tons was above the 13 even-year average of 64.8 metric tons from 1952 to 1976. As would be expected, the good fishing year of 1970 depressed exvessel and wholesale prices in 1971. In January of 1971, inventories were almost triple the holdings of January 1970 (NMFS, Food Fish Situation and Outlook, 1971). The fishing year of

1971 for the United States was very good for an odd year, and the softer prices of 1971 were an inducement for exporting frozen salmon to Japan, France, and the United Kingdom (ibid. p. 29). The United Kingdom was a special target in 1971 for exports since the pound appreciated vis-a-vis the dollar during the year. In the canned salmon markets the effects of wage and price controls were felt acutely and led many exporters to export canned stock rather than sell in the U.S. The light imports in 1971 were partially explained by the large inventories that the U.S. held over from 1970 and by dock strikes which paralyzed most of the West Coast. The West Coast dock strike also induced West Coast wholesalers, particularly Alaskan processors, to hold abnormally high inventories at the processing sites (ibid. p. 30).

Beginning with the fishing year of 1972, hard times hit the industry. The lowest catch since 1967 was packed under the price ceilings based on 1970 pack prices (NMFS, Food Fish Situation and Outlook, December 1972). The result was producer resistance to U.S. trade and a greater emphasis on foreign buyers. It is possible that momentum in the U.S. import trade was gained by the low pack of 1972, although the West Coast dock strike even delayed shipments of import items. Despite what one would normally expect when the catch is low, exports of canned salmon in 1972 were up, and most of it was going to the United Kingdom. The probable reasons are again uncontrolled foreign price and appreciation of the pound vis-a-vis the dollar, as well as the anticipation of a United Kingdom dock strike and a subsequent building of inventories in preparation (ibid. p. 7). The United Kingdom entered the European Common Market (EEC) in 1973, which changed the market condition for canned salmon there. England adopted the EEC tariff rate applicable to the U.S. of 2.5 percent ad valorem. However, the removal of trade preferences with Canada tended to maintain the U.S. presence in the United Kingdom. However, the official devaluation of the pound in 1973 served to counteract, somewhat, the removal of trade preferences with Canada. The yearly catch of 1973 was maintained at low levels again. Imports were down and exports were up; mainly frozen salmon to Europe and Japan. In the presence of U.S. price controls and strong foreign demand (in 1973, according to FAO estimates, Japan imported 16.1 thousand metric tons of frozen salmon, as opposed to the previous year's imports of 1.7 thousand metric tons), the trend in 1973 was again to sell abroad mostly to Japan and the United Kingdom. With a sharp increase in frozen product, the net effect was to depress canned salmon stocks and raise prices. The energy crisis played an important role in further depressing consumption in the following year (1974) by raising prices via increases in transportation costs (NMFS, Food Fish Market Review and Outlook, December 1973).

The year 1974, in terms of catch for the United States, was even worse than the previous year. FAO estimates the catch of salmon for the U.S. as 88,000 metric tons while the Fisheries Statistics of the United States estimates 89.2 thousand metric tons. These two figures represent the lowest catch of the century. However, the canned pack gained at the expense of frozen salmon, mainly because of a prodigious market saturation of frozen salmon that occurred the previous year in Japan (Tables 89 and 90). High prices were also quoted as reason that salmon exports from the U.S. to Europe did not fare well (NMFS, Food Fish Market Review and Outlook, November 1974). More specifically, however, the decrease in exports to the United Kingdom was a result of the entry of the United Kingdom into the Common Market and the devaluation of the pound note. The 1974 Canadian catch was respectable, below the 13 even-year average.

High expectations of a large salmon run in Alaska were not realized in 1975, and while some salmon processors braced themselves for another small pack of salmon, others left the business. Bristol Bay sockeye and Central Alaska pink runs were better than expected (NMFS, Food Fish Market Review and Outlook, November 1975), and with small carry-overs from previous years, resulting mostly from excessive drawdown and only small increases in imports, prices began to take larger jumps. However, any hope of maintaining inventories at a high level through imports from Canada were dissolved when a terrible year for salmon occurred in British Columbia. In addition to the red and chum salmon runs being below par, a three week strike of fishermen, shore-workers, and tenders during the peak run contributed to the disastrous season (ibid. p. 10). The result of the disappointing year in British Columbia tended to depress U.S. importation, but at the same time it also accelerated U.S. export activity to the United Kingdom, since British Columbia was essentially out of the international trade picture for 1975 (ibid. p. 11).

In addition, restriction on Japanese catch by Soviet-Japanese agreement, which, beginning in 1970 restricted all modes of harvest on the high seas to a total quota of below 100 thousand metric tons, undoubtedly reduced Japan's strength on world markets.

The passage of the Fishery Conservation and Management Act (PL 94-265) in the spring of 1976 called for extension of the U.S. jurisdiction of resources out to 200 miles. This new development appears to have passed almost unnoticed for the first year as far as international trade is concerned. The United States, for the first time since 1971, had a fishing year that took more than 100 thousand metric tons of salmon but no one seems to have seriously attributed this success to the enactment of PL 94-265. In contrast, Canada was still recovering from its shock of 1975 with a small improvement to 57.4 thousand metric tons. The catches of both Japan and the USSR had fallen from 1975.

The United States staged a respectable comeback from the poor years of 1974 and 1975. In 1976, however, U.S. exports of fresh/frozen salmon to France and Japan fell, largely because of reduced first-of-the-year trading due to low inventories caused by the bad years (Table 91). The same was true for the canned salmon exports (Table 92). In addition, the improvement in Alaska's catch had the effect of slowing imports of canned and frozen salmon to the United States (Table 93).

TABLE 89

WORLD TRADE OF FROZEN PACIFIC SALMON BY IMPORTING COUNTRIES
(In Thousands of Metric Tons)

Year	Canada[1]	U.S.[1]	Japan	France	U.K.	Sweden	Other[2]	Total
1965	.7	2.6	.6	3.0	2.9	.4	2.0	12.2
1966	1.1	2.7	1.1	4.9	4.6	.7	2.2	17.3
1967	.5	2.9	1.0	5.1	4.4	.7	2.6	17.2
1968	.4	3.2	1.6	4.5	4.0	1.4	2.0	17.1
1969	.7	3.0	7.6	5.1	4.0	2.2	3.4	26.0
1970	2.0	2.6	3.7	5.6	3.4	2.5	3.9	23.7
1971	1.1	2.7	2.7	6.4	3.4	2.9	4.9	24.1
1972	.6	4.4	1.7	9.4	4.6	4.5	5.8	31.0
1973	1.9	4.4	16.3	8.0	4.6	3.6	7.8	46.6
1974	1.3	4.2	2.3	6.8	2.6	3.8	5.1	26.1
1975	1.2	2.7	5.0	12.0	3.4	3.9	8.0	36.2
1976	1.0	2.4	2.2	10.2	3.2	3.3	9.8	32.1

Source: Yearbook of Fishery Statistics - Fishery Commodities, FAO (1961-1976).

[1] Includes imports for re-export.

[2] Also includes exports unspecified by country of destination that might include countries shown above.

TABLE 90

NET IMPORTS OF FROZEN PACIFIC SALMON
BY IMPORTING COUNTRY, 1965-1976
(In Thousands of Metric Tons)

Year	Japan	France	U.K.	Sweden	Other	Total
1965	0.2	3.0	2.9	0.4	2.0	8.5
1966	0.9	4.9	4.6	0.7	2.2	13.3
1967	1.0	5.1	4.4	0.7	2.6	13.8
1968	1.6	4.5	4.0	1.4	2.0	13.5
1969	7.6	5.1	4.0	2.2	3.4	22.3
1970	3.4	5.6	3.4	2.5	3.9	18.8
1971	2.3	6.4	3.4	2.9	4.9	19.9
1972	1.7	9.4	4.6	4.5	5.8	26.0
1973	16.1	8.0	4.6	3.6	7.8	40.1
1974	2.2	6.8	2.6	3.8	5.1	20.5
1975	3.6	12.0	3.4	3.9	8.0	30.9
1976	*	10.2	3.2	3.3	9.8	26.5

Source: Yearbook of Fishery Statistics - Fishery Commodities, Rome, Italy, FAO, 1965-1976, (Annual).

*Net imports have been derived by subtracting each country's total frozen exports from its frozen imports.

TABLE 91

U.S. EXPORTS OF DOMESTIC FRESH AND FROZEN SALMON BY COUNTRY OF DESTINATION, 1963 TO 1977

COUNTRY	1963	1964	1965	1966	1967	Average
Belgium	192	184	405	503	692	401
Canada	1,252	1,364	2,460	3,779	2,527	2,276
Denmark	52	65	83	408	172	156
France	1,549	2,298	2,545	4,701	5,216	3,262
Germany, Fed. Rep. of	136	34	170	327	443	222
Japan	4	16,007	1,347	2,468	2,218	4,409
Netherlands	116	174	168	172	625	251
Sweden	24	169	833	1,636	1,644	861
United Kingdom	1,478	2,139	2,287	5,163	4,635	3,140
Other	85	126	261	661	739	
Total	4,888	22,560	10,559	19,845	18,911	

COUNTRY	1968	1969	1970	1971	1972	5 Year Average
Belgium	673	790	1,113	1,152	1,502	1,046
Canada	1,255	2,567	4,361	3,983	2,697	2,973
Denmark	53	443	698	466	544	441
France	3,980	4,298	5,605	6,955	10,608	6,289
Germany, Fed. Rep. of	205	448	401	536	770	472
Japan	2,912	14,137	7,676	9,492	3,485	7,540
Netherlands	392	551	337	522	802	521
Sweden	1,826	2,367	3,012	3,389	6,302	3,379
United Kingdom	4,360	4,004	4,221	4,872	6,232	4,738
Other	578	948	777	1,524	1,743	
Total	16,234	30,553	28,201	32,891	34,685	

COUNTRY	1973	1974	1975	1976	1977	5 Year Average
Belgium	2,250	1,921	2,433	2,288	1,783	2,135
Canada	4,283	2,789	2,585	2,277	5,466	3,480
Denmark	881	600	1,568	1,703	1,772	1,305
France	8,618	6,945	14,335	14,100	12,883	11,376
Germany, Fed. Rep. of	1,198	864	1,725	1,714	1,810	1,462
Japan	25,162	3,835	9,452	4,275	31,854	14,932
Netherlands	1,775	892	1,550	1,721	1,172	1,422
Sweden	3,991	4,092	5,030	3,807	3,934	4,171
United Kingdom	6,065	3,426	6,006	5,422	3,622	4,908
Other	1,473	745	1,012	1,111	1,263	
Total	55,696	26,109	45,696	38,418	65,559	

Source: U.S. Department of Commerce, NMFS, Fisheries of the United States, 1963 to 1977.

TABLE 92

TOTAL WORLD TRADE OF CANNED PACIFIC SALMON BY EXPORTING COUNTRIES
(In Thousands of Metic Tons)

Year	Canada		Japan		U.S.		Russia		Total	
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
1961	8.4	20.0	26.7	63.4	3.3	7.8	3.7	8.8	42.1	100.0
1962	10.7	14.4	55.2	74.4	4.1	5.5	4.2	5.7	74.2	100.0
1963	15.3	28.4	29.8	55.4	4.6	8.6	4.1	7.6	53.8	100.0
1964	18.0	30.6	28.1	47.8	9.5	16.2	3.2	5.4	58.8	100.0
1965	12.0	18.6	37.7	58.4	11.3	17.5	3.6	5.6	64.6	100.0
1966	11.6	24.5	22.9	48.3	9.3	19.6	3.6	7.6	47.4	100.0
1967	19.8	33.4	27.5	46.4	9.3	15.7	2.7	4.6	59.3	100.0
1968	18.1	28.6	38.1	60.0	2.6	4.1	4.6	7.3	63.4	100.0
1969	15.9	32.5	22.3	45.6	7.0	14.3	3.7	7.6	48.9	100.0
1970	7.0	16.2	24.0	55.4	7.6	17.6	4.7	10.9	43.3	100.0
1971	10.9	20.8	28.6	54.7	8.3	15.9	4.5	8.6	52.3	100.0
1972	13.5	23.4	30.4	52.6	9.7	16.8	4.2	7.3	57.8	100.0
1973	17.3	40.0	13.4	31.1	7.7	17.8	4.8	11.1	43.2	100.0
1974	12.9	38.7	12.9	38.7	3.8	11.4	3.7	11.1	33.3	100.0
1975	7.1	18.0	17.7	44.8	10.2	25.8	4.5	11.4	39.5	100.0
1976	7.3	18.2	18.5	46.0	8.9	22.1	5.5	13.7	40.2	100.0

Source: Yearbook of Fishery Statistics, Fishery Commodities, FAO (1961 to 1976)

TABLE 93

TOTAL WORLD TRADE OF CANNED PACIFIC SALMON BY IMPORTING COUNTRIES
(In Thousands of Metric Tons)

Year	United Kingdom		Australia		Belg. Luxem.		Nether-lands		France		Italy		New Zealand		United States		Other[1]		Total
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%	Tons
1961	22.1	52.5	4.6	10.9	2.5	5.9	2.4	5.7	1.0	2.4	.4	.9	.9	2.1	3.1	7.4	5.1	12.1	42.1
1962	55.3	74.5	3.7	5.0	2.0	2.7	1.7	2.3	.9	1.2	.4	.5	.7	.9	3.2	4.3	6.3	8.5	74.2
1963	33.5	62.3	4.4	8.2	2.7	9.0	2.3	4.3	2.3	4.3	.9	1.7	1.1	2.0	.5	.9	6.1	11.3	53.8
1964	37.2	63.3	5.5	9.4	4.0	6.8	3.1	5.3	1.6	2.7	.6	1.0	1.2	2.0	---	---	5.6	9.5	58.8
1965	42.8	66.3	5.6	8.7	3.2	5.0	3.5	5.4	1.5	2.3	.3	.5	1.3	2.0	.1	.2	6.3	9.8	64.6
1966	28.4	59.9	5.4	11.4	2.6	5.5	2.1	4.4	1.4	3.0	.6	1.3	.8	1.7	.2	.4	5.9	12.4	47.4
1967	40.1	67.6	4.7	7.9	3.3	5.6	2.7	4.6	1.2	2.0	.7	1.2	.7	1.2	.2	.3	5.7	9.6	59.3
1968	43.4	68.4	4.2	6.6	2.5	3.9	2.4	3.8	1.7	2.7	.4	.6	.7	1.1	2.4	3.8	5.7	9.0	63.4
1969	29.2	59.7	4.9	10.0	3.2	6.5	2.4	4.9	1.2	2.5	.3	.6	.7	1.4	1.3	2.7	5.7	11.7	48.9
1970	25.4	58.7	2.9	6.7	1.8	4.2	2.6	6.0	1.0	2.3	.5	1.2	1.2	2.8	---	---	7.9	18.2	43.3
1971	30.1	57.6	5.1	9.8	3.3	6.3	2.8	5.4	2.0	3.8	.4	.8	.9	1.7	1.0	1.9	6.7	12.8	52.3
1972	30.6	52.9	5.7	9.9	2.8	4.8	3.0	5.2	2.8	4.8	.3	.5	.9	1.6	5.7	9.9	6.0	10.4	57.8
1973	24.1	55.8	3.7	2.8	2.9	6.7	1.5	3.5	1.5	3.5	.3	.7	1.5	3.5	1.7	3.9	6.0	13.9	43.2
1974	14.9	44.7	4.1	12.3	2.2	6.6	1.4	4.2	.7	2.1	.2	.6	.6	1.8	3.3	9.9	5.9	17.7	33.3
1975	20.7	52.4	2.5	6.3	2.8	7.1	2.8	7.1	.9	2.3	--	--	.5	1.3	1.3	3.3	8.0	20.3	39.5
1976	18.2	45.3	5.7	14.2	3.6	9.0	3.5	8.7	1.5	3.7	--	--	.8	2.0	.6	1.5	6.3	15.7	40.2

Source: Yearbook of Fishery Statistics, Fishery Commodities, FAO (1961-1976).

[1]Small quantities of exports to countries listed could be included under this column.

The large 1977 canned and frozen salmon pack is a direct result of vastly improved salmon catch in Alaska, despite strikes in Kodiak. In response to the higher catch, wholesale prices for the fourth quarter took a slight dip. The historical Japanese buying spree of fresh/frozen salmon in 1973 seems to have been repeated in 1977 with almost 13 thousand metric tons sold, according to Japan Marine Products Importers Association (JMPIA). A possible reason for the aggressive Japanese market is the rough negotiations with the USSR on Japanese salmon fishery within Soviet 200-mile limits. The United Kingdom pound fell to an all-time low in 1977 against the dollar. This tended to discourage exports to the United Kingdom.

Alaska's unusually brisk trade relations with Japan in 1978 rose from developments that occurred in the North Pacific:

1. The steadily devaluing dollar vis-a-vis the yen.

2. The recognition of the 200-mile economic resource zone by most countries has diminished Japan's role as a major fishing power. One of the most recent blows to the Japanese salmon fishery was the five-year Japan-Soviet Bilateral Fishery Cooperation Agreement signed into effect in April 1978. This was a direct result of the exercise of a claim of parent-stream jurisdiction beyond 200 miles by the Soviets. The 1978 agreement reduced the Japanese quota by 31 percent from the 1977 quotas.

3. The revised North Pacific Fishery Convention agreed to in April 1978 establishes strict restrictions on salmon fishing in open seas outside the 200-mile fishery zones. Waters west of 175° east longitude are the confines of landbased fishing operations. Mothership operations are restricted to:

    (a) No fishing before June 26 in an area bounded by 175° east and 175° west longitude north of the U.S. 200-mile boundary in the Northern Bering Sea.

    (b) Operations in areas described by (a) are limited to 31 fleet days in waters east and to 22 days west of 180° longitude.

    (c) In open sea areas bounded by 170° east and 175° east longitude both north and south of the Aleutians, no fishery is to take place prior to June 1.

    (d) In U.S. 200-mile waters west of 175° east longitude, there should be no fishing prior to June 10.

These developments influenced Japan's shift from being an exporting nation to one which now imports materials in practically every category. The canned salmon industry in Japan is having difficulties (Suisan Keizai Shinbun 1978b). Compensating arrangements for retired gillnetting vessels are becoming a burgeoning reality and the amount of frozen drawn salmon of all species destined for Japan from the U.S. is cutting deeply into the canning of salmon in the United States. This exhibited itself as higher salmon prices, despite the record year of 1978.

Trade Barriers

Table 94 describes some of the tariff rates for salmon products from 1930 to 1976. The year 1930 is a significant one in the history of the U.S. import tariff because of the impact that the Tariff Act of 1930 (popularly called the Hawley-Smoot Act) had on the nation's economy. The Tariff Act of 1930 was passed under conditions quite different from those obtained for the long series of preceding measures (Taussig 1931). All pretense of giving tariff concessions for U.S. producers according to their need for "protection" were dropped. Strong protectionism flared, and was fueled by logrolling both in the Senate Finance Committee and the House Ways and Means Committee. Thus the original intent of President Hoover in 1929 to address agricultural problems of the country by limited revision of the tariff schedules derived in 1922 was largely expanded upon, and included many fish products like salmon. It took nearly 30 years of tariff adjustments to bring tariff rates down to par with pre-1930s; this experience with the Hawley-Smoot Act may have been the reason for the Reciprocal Trade Agreements Act of 1934, which essentially was the beginning of a shift in tariff-making power from the Congress to the Executive Branch.

However, the most important and contentious executive trade agreement signed by the United States is the General Agreement on Tariffs and Trade (GATT) which came into force January 1948 (Mackenzie 1968). The GATT framework is an international trade regulatory body that was supposed to be temporary but instead has become the surrogate for a formal commission. Congress never formally addressed the existence of GATT. However, executive powers to reduce tariffs in reciprocal agreements were addressed in 1962 at the urging of President Kennedy. This request by the Executive Branch for a free rein in tariff making became the Trade Expansion Act of 1962, which gave the president the power to make reciprocal tariff reduction of up to 50 percent. The most extensive negotiation with which the United States has been involved was the Kennedy round of GATT which concluded in May 1967. The U.S. participation in this round was largely made possible by the Trade Expansion Act of 1962. The effective date of the stepwise reduction in tariff rates was January 1968 and gradual reductions were to occur on a yearly basis over most commodities for up to five years. The reductions in tariffs for salmon products are shown in Table 94. Taken alone, the reduction of trade barriers on the imports of salmon products should have caused an influx of imports. However, other factors, such as the exchange rate and the limited number of suppliers in the world have been of far greater significance to salmon trade than the trade barriers, especially in recent years.

TABLE 94

U.S. TRADE BARRIERS ON THE IMPORTATION OF SALMON PRODUCTS[1]

	1930	1960	1968	1969	1970	1971	1972	1976
Fresh or frozen								
Whole, beheaded, eviscerated	2.00¢	0.50¢	0.40¢	0.30¢	FREE	FREE	FREE	FREE
filleted, skinned, boned	2.50¢	1.50¢	1.00¢	0.90¢	0.50¢	0.30¢	FREE	FREE
Canned or airtight containers								
In oil or oil and other substances	30.0%	25.5%	22.5%	20.0%	17.5%	15.0%	12.5%	12.5%
Not in oil or oil with other substances; not over 15 pounds each	25.0%	15.0%	13.0%	12.0%	10.0%	9.0%	7.5%	7.5%
Pickled or salted								
(Except in oil and except in airtight containers weighing with contents not over 15 pounds each)	25.0%	8.5%	7.5%	6.5%	5.5%	5.0%	4.0%	4.0%
Smoked or kippered								
(Not in oil and not in air-tight containers weighing with contents 15 pounds or less)	25.0%	10.0%	9.0%	8.0%	7.0%	6.0%	5.0%	5.0%
Fish prepared or preserved not otherwise provided for								
In oil	30.0%	25.5%	22.5%	20.0%	17.5%	15.0%	12.5%	12.5%
Not in oil								
In bulk or in immediate containers, weighing with their contents over 15 pounds each	1.25¢	1.00¢	0.80¢	0.50¢	0.40%	0.20¢	FREE	FREE
Not in bulk or in containers weighing over 15 pounds each	25.0%	12.5%	11.0%	10.0%	8.5%	7.0%	6.0%	6.0%

Source: United States Bureau of Census. Tariff Schedules of the United States Annotated; various years.

[1]Values expressed in cents refere to cents per pound. Values expressed as percentage refer to percent ad valorem.

Exchange Rates

Table 95 provides information on how U.S. exports of domestic fresh and frozen salmon might vary as a function of the exchange rate of major buyers of salmon. In 1971, the U.S. made a radical departure from the 1944 agreements at Breton Woods, and as a result, took the first steps toward a free-floating currency market. It is not surprising that the Smithsonian Agreement among the Group of Ten, Nixon's first phase of the wage and price freeze, and the temporary 10 percent tariff on all imported goods appeared to have happened simultaneously. Under the evolving system, the demand in the U.S. for foreign currencies for payment on goods received from abroad became the mechanism by which balance of payments was achieved.

In a tendency for the total supply of a good or service to be equal to its total demand over all regions, balance of trade is thus obtained vis-a-vis an exhange rate. The demand then for foreign currencies to pay for goods bought is reflected in the trade relationship between two countries. An excellent example of the effect the foreign exchange rate has on exports is the U.S. relationship to Japan. The yen was more or less tightly controlled until 1971 when the value of the yen in terms of dollars appreciated rapidly (Table 95). The reason for this rapid decline in the dollar was the trade deficit built up with Japan. Recently, the Japanese have been responding to this devaluation by being an aggressive foreign buyer of products for which Japan has an excess demand (fish products). Simple correlations of fresh/frozen salmon exports and exchange rates suggest that there is a significant (at the five percent level) inverse relationship between the exchange rate and U.S. exports to Japan. This implies that Japanese export trade, in effect, has provided an upward pressure on domestic prices of salmon by bidding a greater part of the U.S. catch away from domestic use. If no external forces retard equilibrium, subsequent devaluation of the dollar will accelerate this activity and will continue until the same relative price (taking into account exchange rates, transportation costs, and trade barriers) is charged in both countries for the same products. The trade years of 1977 and 1978 seem to add weight to the argument. However, for Canada, France, and the United Kingdom, this relationship may not be as easily identified.

Summary and Projections

It appears that, for the time being, the salmon resource is on the road to recovery, although it would be hard to conclusively tie its strong comeback since 1976 with changes in U.S. and Alaska state policy.

The United States is one of the major world suppliers of salmon, and Alaska is the major producer in the United States. As a consequence, the resource management activities in Alaska have an almost direct bearing on world trade, and, as it has already been seen in other fisheries, the planning of the production and marketing has the potential of being greatly enhanced by accurate forecasts of salmon abundance of the allowable harvest. This information prior to a season may be of enormous importance in negotiating abroad.

TABLE 95

EXCHANGE RATES FOR THE FOUR MAJOR IMPORTING COUNTRIES OF SALMON FROM THE U.S.
(In Cents Per Unit of Foreign Currency)

	Canada (dollar)	France (franc)	Japan (yen)	United Kingdom (pound)
1960	103.122	20.389	.27785	280.76
1961	98.760	20.384	.27690	280.22
1962	93.561	20.405	.27712	280.78
1963	92.699	20.404[1]	.27663	280.00
1964	92.689	20.404	.27625	279.21
1965	92.743	20.401	.27662	279.59
1966	92.811	20.352	.27598	279.30
1967	92.689	20.323	.27613	275.04
1968	92.801	20.191	.27735	239.35
1969	92.855	19.302	.27903	239.01
1970	95.802	18.087	.27921	239.59
1971	99.021	18.148	.28799	244.42
1972	100.937	19.825	.32995	250.08
1973	99.977	22.536	.36915	245.10
1974	102.26	20.805	.34302	234.03
1975	98.30	23.354	.33705	222.16
1976	101.41	20.942	.33741	180.48
1977	94.112	20.344	.37342	174.49
1978(July)	88.921	22.531	.50101	189.49

Source: Federal Reserve Bulletin; December 1971, 1972, 1973, 1974, 1975, 1976, and 1977; August, 1978.

[1]Effective January 1, 1963, the franc became the French monetary unit.

The United States exporters of fish products have an advantage in world trade at this time because of the relative weakness of the dollar abroad. However, a revaluation of the dollar might tend to decrease the willingness of foreign buyers to buy, just as the appreciation of the yen throughout the year of 1977 tended to discourage U.S. buyers of some fish exports from Japan. The United States is a direct competitor with Japan and Canada for export markets. Two of the major buyers of salmon, besides Japan, have been France and the United Kingdom. Japan, Alaska's most important customer, seems to be willing to pay ever increasing amounts for items like salmon roe, one of the principal fish products, in terms of value, that is exported to Japan. The prices of "Sujiko" have shown that despite the plunging value of the dollar, the price increase (in dollars per pound) of Sujiko was proportionately higher than the dollar devaluation between September 12, 1977 and September 15, 1978.

In the United States, market stagnation for canned and frozen salmon is more likely; first, because of the American propensity to consume meat and poultry, and second, because of the tendency of canned tuna to be substituted in the place of canned salmon during price increases for canned salmon. This, of course, is a well-known substitution effect which may partially explain why more salmon is being frozen in the United States every year. It could be better to compete with other frozen luxury foods than to battle it out with the strong market presence of tuna, which is not likely to go away unless U.S. tuna producers encounter supply problems. However, the reality of the situation is that, even for frozen salmon, some processors who produce for the retail supermarkets feel that they are even pushed out of that market in the U.S. (Ruthford 1978). This is felt to be partly because the product is in limited "demand" and also because handling techniques in supermarkets do not always lend themselves to high quality seafood. The other obvious point, however, is that the American consumer does not tend to do much home cooking anyway and is, in fact, going out to eat more often. This is evidenced by the rapid growth of restaurant and restaurant-related services. However, the other side of the story is that the most impressive increases that have occurred in the restaurant trade have been in fast-food service, which does not normally serve salmon as a standard menu item. Rather, the greatest customers for salmon and salmon products are the higher-priced eating establishments, which are growing at a slower rate than fast-food restaurants.

The harvesting sector principally uses the same types of gear that have been used since statehood, except that there have been subtle refinements in both the materials and the methods of fishing. Both the Alaska Department of Fish and Game regulatory activity and the Commercial Fisheries Entry Commission have limited methods and materials used in the harvesting which have led fishermen to invest in other types of capital improvements that directly or indirectly increase efficiency.

The processing sector of Alaska has become increasingly involved in attracting Japanese investment for capital expansion and, apparently, the Japanese have been more than willing to respond, especially considering that control of supply by the Japanese may be easily achieved by investment in American firms. This topic has recently claimed much attention because of the equity questions that arise when distributions of products appear to be conducted by systems other than "free markets." The indeterminate condition of the resource itself makes it a risky venture to invest in fixed capital equipment for processing. However, the season of 1978 left Bristol Bay and some parts of Southeast Alaska in a state of undercapacity. The story was repeated again in 1979 but for this season, the repercussions were acute. Fishermen were put on quotas by canners and some were even informed that processing services would not be available to them in the upcoming season. Many inexperienced buyers, intrigued at the thought of large profits on poor qualtiy fish bought at a discount, went bankrupt attempting to sell to the more cagey European and Japanese buyer. The bad fish that did get through further weakened the credibility of Alaskan frozen salmon on world markets. From this standpoint the season of 1980, although a bumper year for salmon in Bristol Bay, is likely to look very grim to the heavily mortgaged fisherman. The realization that temporary capacity must be built up or arranged for during levels of high production, may prompt the development of short-term capacity increasing equipment or arrangements to serve in lieu of fixed capacity. To this end, containerized air and surface transport of primarily processed fish to other points with idle capacity during the salmon season will be playing a greater role in alleviating capacity problems in some Alaska plants.

Real prices for frozen and canned salmon in the United States have been increasing yearly as per capita consumption has been decreasing. All of these observations suggest that the availability of this luxury food item is determined domestically by the seasonal fishing success and the amount exported overseas. Other countries, especially Japan, directly compete for the U.S. supply of salmon, not only with other countries, but also with the American consumer. The distribution of salmon according to product type, then, is an excellent example of the forces of interregional trade, where the excess demand for one country (Japan) is satisfied by the excess supply of another country (the United States), which tends to produce a new price equilibrium. This reflects not only interregional supply and demand but also the exchange rate and trade barriers. Thus, it is entirely possible that the price of canned and frozen salmon in the United States will continue to rise, unless a strong revaluation of the dollar produces market stagnation between the United States and Japan.

APPENDIXES

APPENDIX I

CHANGES IN THE REGULATORY AREAS, LENGTH OF THE SEASON, AND THE QUOTA FROM 1932 TO 1976, AS REPORTED IN IPHC TECHNICAL REPORT NUMBER 15 (SKUD 1977b)

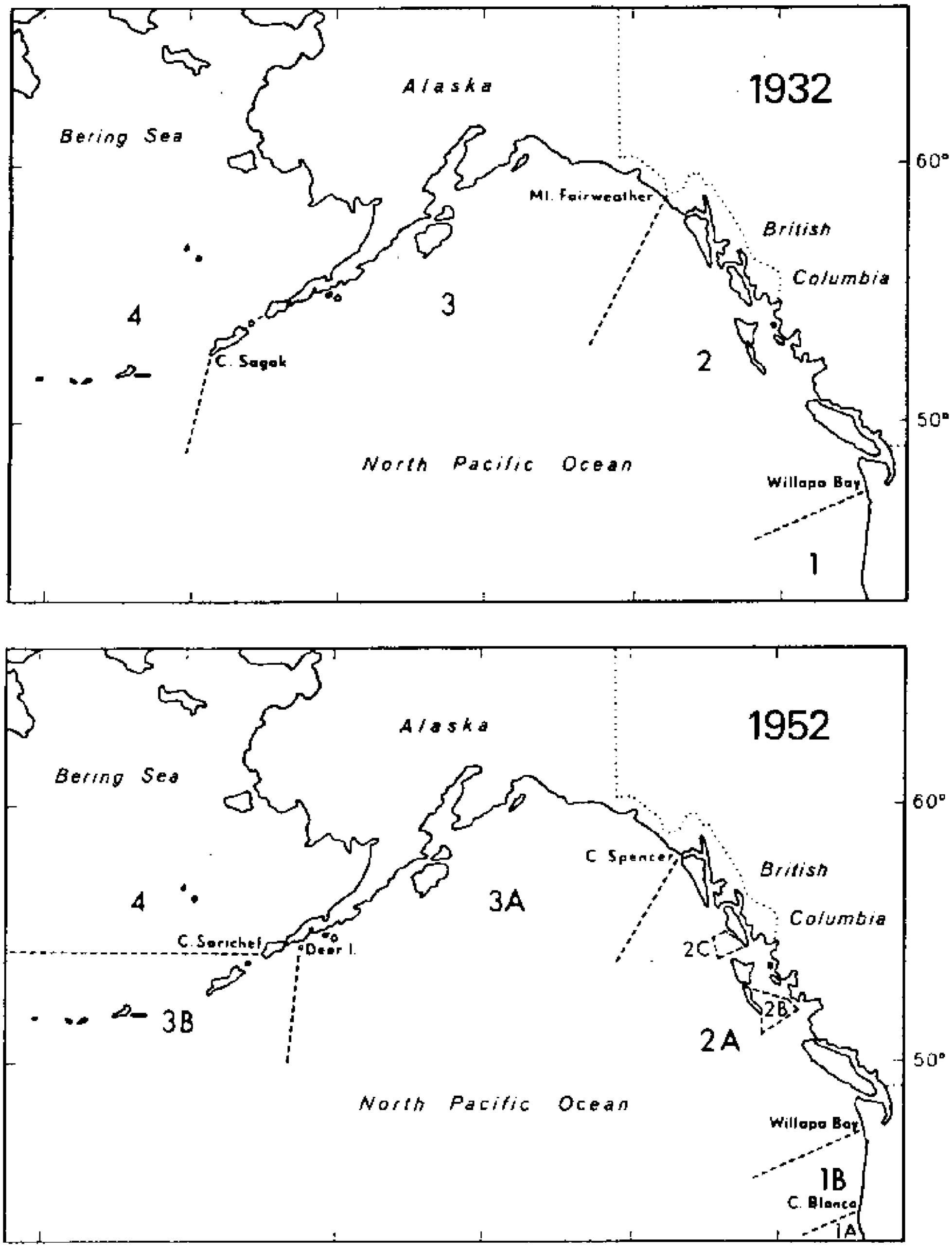


FIGURE I-1. REGULATORY AREAS FOR THE HALIBUT FISHERY, 1932 TO 1952.

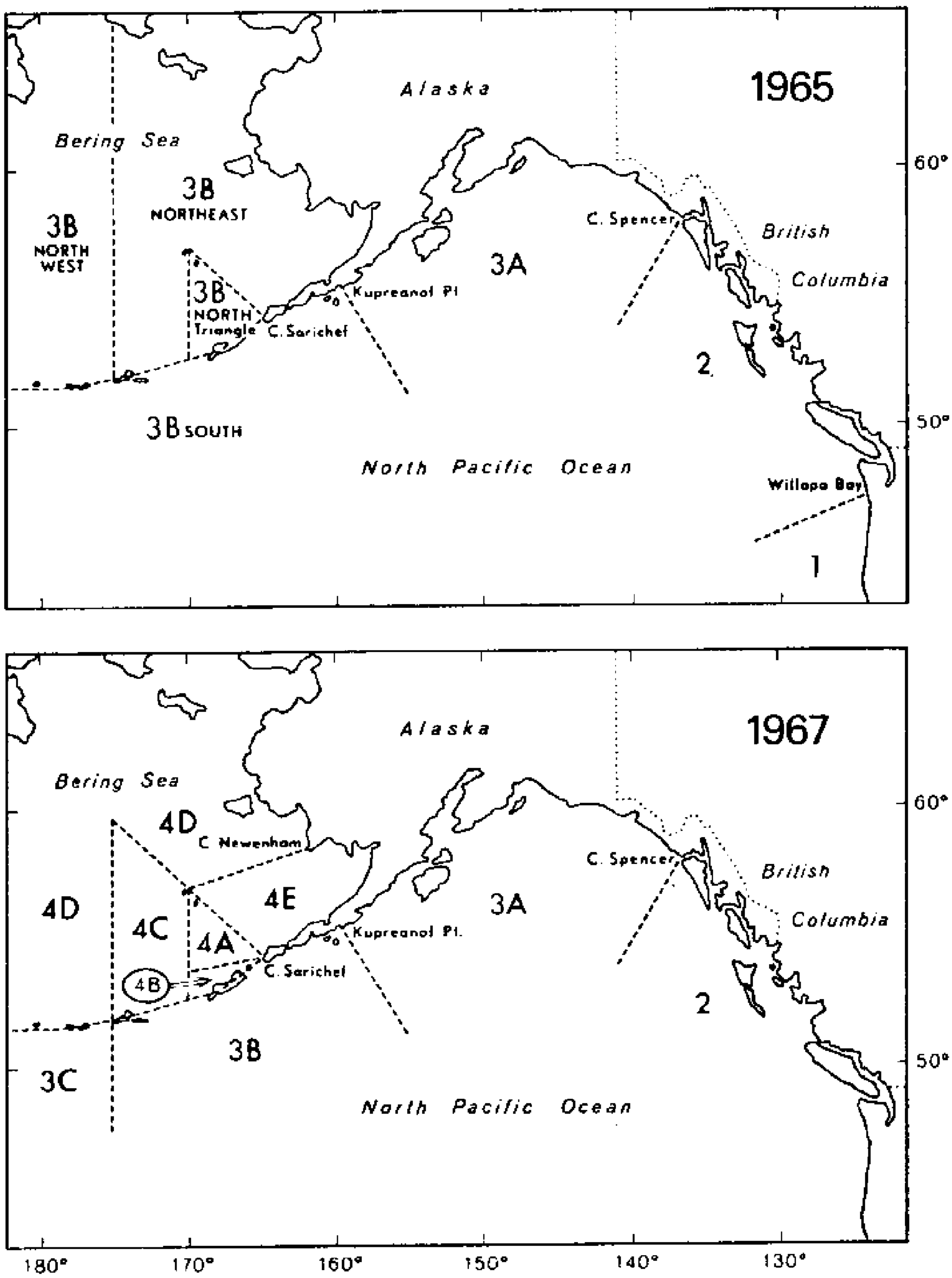


FIGURE I-2. REGULATORY AREAS FOR THE HALIBUT FISHERY, 1962 TO 1967.

TABLE I-1

QUOTA AND CATCH BY REGULATORY AREA, 1932 TO 1976*
(In Thousands of Pounds)

	AREA 1		AREA 2		AREA 3		AREA 4	
Year	Quota	Catch	Quota	Catch	Quota	Catch	Quota	Catch
1932		869	22,500	21,986	23,500	21,599		
1933		741	21,700	22,530	24,300	23,506		18
1934	1,400	1,614	21,700	22,363	24,300	23,569		
1935		1,492	21,700	22,067	24,300	23,784		
1936		714	21,700	22,605	24,300	25,604		
1937		714	21,700	23,359	24,300	25,466		
1938		718	22,700	23,391	25,300	25,444		
1939		1,091	22,700	24,499	25,300	25,313		
1940		825	22,700	25,578	25,300	26,978		
1941		349	22,700	23,941	26,300	27,941		
1942		290	22,700	23,144	26,800	26,954		
1943		428	23,000	24,933	27,500	28,338		
1944		326	23,500	26,023	27,500	27,086		
1945		443	24,500	23,353	28,000	29,594		5
1946		574	24,500	28,594	28,000	31,098		
1947		409	24,500	27,330	28,000	27,961	500	
1948		259	25,500	27,568	28,000	27,737	500	
1949		385	25,500	26,027	28,000	28,613	500	
1950		377	25,500	26,620	28,000	30,237	500	
1951		289	25,500	30,309	28,000	25,447	500	
1952		320	25,500	30,488	28,000	31,202		252
1953		210	25,500	32,501	28,000	26,899		227
1954		551	26,500	36,240	28,000	33,751		41
1955		377	26,500	27,429	28,000	29,670		45
1956		325	26,500	34,772	28,000	31,229		262
1957		296	26,500	30,238	30,000	30,281		39
1958		212	26,500	29,998	30,000	32,122		2,176
1959		129	26,500	30,401	30,000	36,517		4,157
1960		238	26,500	31,520	30,000	34,198		5,649
1961		223	28,000	28,637	33,000	36,446		3,968
1962		275	28,000	28,443	33,000	38,222		7,322
1963		169	28,000	26,001	34,000	36,931	11,000	8,136
1964		104	25,000	19,465	38,000	37,887	6,393	2,328
1965		98	23,000	24,154	38,000	37,589		1,335
1966		81	23,000	23,178	36,500	37,562		1,195
1967			23,000	19,719	36,500	33,108		2,395
1968			23,000	16,394	35,500	30,879		1,321
1969			21,000	22,377	34,500	34,665		1,233
1970			20,000	19,885	33,000	33,919		1,134
1971			20,000	16,773	33,000	29,015		866
1972			15,000	16,283	25,000	25,869		732
1973			13,000	12,929	25,000	18,525		286
1974			13,000	10,744	12,000	10,125		437
1975			13,000	13,830	12,000	13,261		525
1976			13,000	13,048	12,000	13,964		523

* The catch includes poundage taken during special seasons without quotas or from permit fishing. Area 1 was incorporated as part of Area 2 in 1967. The quotas for Area 3 from 1964 to 1971 include quotas for Area 3B, which was managed separately in those years. Japanese longline catches in Area 4 are not included. The quotas for Area 4 in 1963 and 1964 also applied to the Japanese fleet.

TABLE I-2

OPENING AND CLOSING DATES AND LENGTH OF SEASON, 1932 TO 1976

	AREA 2			AREA 3A		
Year	Opening Date	Closing Date	Length of Season*	Opening Date	Closing Date	Length of Season*
	Month/Day	Month/Day	Days	Month/Day	Month/Day	Days
1932	2-16	10-22	250*	2-16	10-30	259
1933	2-01	8-25	206	2-01	10-26	268
1934	3-01	8-19	172	3-01	10-27	241
1935	3-01	9-06	159	3-01	12-26	270
1936	3-16	8-10	148	3-16	11-03	233
1937	3-16	7-28	135	3-16	10-19	218
1938	4-01	7-29	120	4-01	10-29	212
1939	4-01	7-29	120	4-01	10-28	211
1940	4-01	7-13	104	4-01	9-26	179
1941	4-01	6-30	91	4-01	9-14	167
1942	4-16	6-29	75	4-16	9-25	163
1943	4-16	6-20	66	4-16	9-08	146
1944	4-16	7-09	51	4-16	11-30	195
1945	5-01	6-15	46	5-01	9-24	147
1946	5-01	6-11	42	5-01	8-19	111
1947	5-01	6-08	39	5-01	8-17	109
1948	5-01	6-01	32	5-01	7-11	72
1949	5-01	6-03	34	5-01	7-12	73
1950	5-01	6-01	32	5-01	7-05	66
1951	5-01	5-28	38	5-01	6-25	56
1952	5-14	6-08	36	5-14	7-12	60
1953	5-17	6-09	34	5-17	7-07	52
1954	5-16	6-05	29	5-16	7-12	68
1955	5-12	6-05	31	5-12	8-04	93
1956	5-12	6-27	45	5-12	8-24	105
1957	5-01	6-17	54	5-01	9-22	144
1958	5-04	7-02	66	5-04	8-31	119
1959	5-01	7-08	75	5-01	8-01	92
1960	5-01	7-31	98	5-01	7-25	85
1961	5-10	9-07	120	5-10	8-23	105
1962	5-09	9-08	122	5-09	8-11	94
1963	5-09	11-30	205	5-09	8-09	92
1964	5-01	9-15	137	5-01	8-19	110
1965	5-01	9-15	137	5-01	8-26	117
1966	5-09	8-25	108	5-09	8-15	98
1967	5-09	10-15	159	5-09	10-15	159
1968	5-04	10-15	164	5-04	10-15	164
1969	5-07	9-21	137	5-07	9-22	138
1970	4-25	9-21	149	4-25	9-21	149
1971	5-07	11-01	178	5-07	11-01	178
1972	5-01	8-10	101	5-01	9-14	136
1973	5-10	8-13	95	5-10	10-01	144
1974	5-17	9-15	121	5-17	9-15	121
1975	5-01	9-06	128	5-01	9-06	128
1976	5-08	9-08	123	5-08	8-12	96

* In 1935, 1944, and 1956, the fleet did not begin fishing on the opening date because of externalities such as price disputes. These non-fishing periods are excluded from the length of the season. In Area 2 from 1951 to 1960, the number of fishing days includes special seasons of 7 to 10 days. In Area 3 from 1954 to 1956, the number of fishing days includes special seasons of 9 to 10 days.

APPENDIX II

FOREIGN TRAWL CLOSURES AND CHRONOLOGY OF REGULATIONS BY INTERNATIONAL PACIFIC HALIBUT COMMISSION AS REPORTED IN IPHC TECHNICAL REPORT NUMBER 15

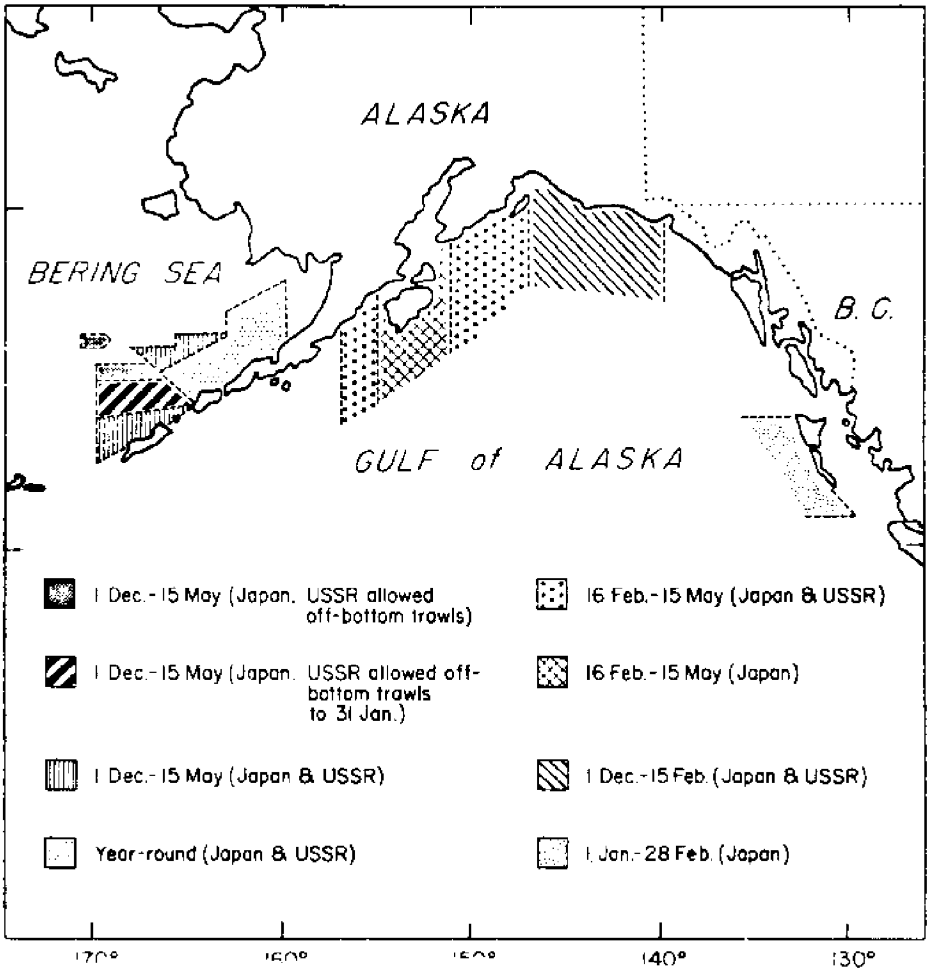


FIGURE II-1. FOREIGN TRAWL CLOSURES PERTAINING TO HALIBUT IN THE BERING SEA AND THE GULF OF ALASKA.

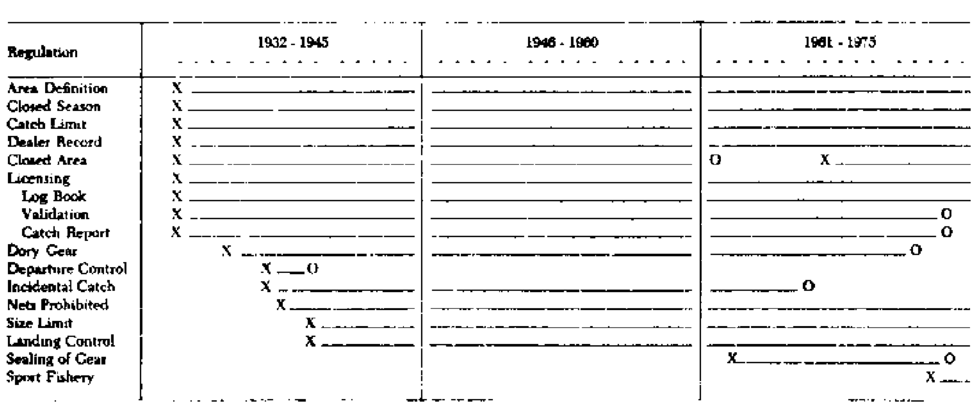


FIGURE II-2. CHRONOLOGY OF IPHC REGULATIONS, 1932 TO 1975. X = YEAR INTRODUCED, O = YEAR DELETED.

APPENDIX III

A SUMMARY OF THE ESTIMATED HALIBUT CATCH BY JAPAN AND USSR IN THE BERING SEA AND THE NORTH PACIFIC AS REPORTED BY HOAG AND FRENCH (1976)

(One table)

TABLE III-1

SUMMARY OF ESTIMATED HALIBUT CATCH BY FOREIGN TRAWLERS IN THE BERING SEA AND THE NORTHEAST PACIFIC, 1954 TO 1974
(In Metric Tons)

	BERING SEA				NORTHEAST PACIFIC		
	Japan						
Year	Mothership-Independent Fleet	Land-Based Fleet	U.S.S.R.	Total	Japan	U.S.S.R.	Total
1954	52			52			
1955	42			42			
1956	102			102			
1957	102			102			
1958	168			168			
1959	520		374	894			
1960	1,590		576	2,166			
1961	2,303		926	3,229			
1962	1,420	112	837	2,369		1,290	1,290
1963	125	659	555	1,339		2,976	2,976
1964	412	1,278	476	2,166	390	5,932	6,322
1965	440	1,386	540	2,366	668	8,435	9,103
1966	693	2,533	600	3,826	1,022	5,286	6,308
1967	1,341	5,301	738	7,380	1,549	3,273	4,822
1968	1,765	3,582	592	5,939	1,567	2,359	3,926
1969	2,176	3,594	972	6,742	1,122	1,491	2,613
1970	2,759	5,677	957	9,393	1,154	1,794	2,948
1971	3,484	5,728	2,307	11,519	995	1,075	2,070
1972	3,259	3,678	2,178	9,115	1,387	2,544	3,931
1973	2,567	2,489	1,987	7,043	1,816	1,679	3,495
1974	1,807	1,581	2,458	5,846	1,840	2,168	4,008

APPENDIX IV

A DIGRESSION ON CATCH VERSUS LANDINGS AND AN EXPLANATION OF CATCH, LANDINGS AND PRODUCTION DATA PRESENTED IN THIS REPORT.

Because of the long-standing international cooperation between the United States and Canada concerning the halibut fishery, and the fact that the ocean off the coast of Alaska supports a fishery that other states and countries enjoy, the distinction between "catch" and "landing" becomes an important issue. The impact of the Alaska halibut fishery on the world market has in the past extended considerably beyond what is processed in the state. Alaska's "catch" has heretofore far outstripped its state landings and production, and consequently U.S. prices and quantities for some fish species, notably halibut, salmon and crab stand or fall on the success of the year in Alaska.

With the exception of the IPHC and FAO, other agencies seem to use the terms "catch" and "landing" almost interchangeably in some fishing statistics. However, the two do not seem to be strict synonyms in other forms of data (as with data generated by IPHC). The term "catch" conjures up visions of fish being pulled aboard somewhere out on the ocean. For purposes of management, the ocean has been divided into areas and these areas denote general locations where fish have been taken. Where and how much fish is landed in port is entirely different information, which may or may not roughly correspond to the area where it was caught. The location of the catch strongly determines where fish are landed, but just as important are season lengths, fuel costs, or good processor-fishermen relationships. One must also contend with the possibility that the landed product is considerably different than it was at sea. That the value of catch, to the fisherman, is considerably more if labor, fuel, and refrigeration becomes a part of the catch's product identity. For this reason, this report uses catch and landings from IPHC, and production figures for Alaska from various federal agencies and the Alaska Department of Fish and Game. Several desirable features exist in each data base, but some inconsistencies are evident due to the manner in which both types of statistics are reported. The weight of products as prepared for market supplied by the U.S. Department of the Interior until 1960 has the landings of U.S. registered vessels in British Columbia included with the figures, and although most of these products do end up in the U.S., there is no way to tell what quantity was actually produced in Alaska. Landings and catch data from U.S. Statistical Digests were not used in this report for several reasons, one of which is outlined here. Until recently, the ultimate source of catch and landings statistics for halibut was the IPHC. In U.S. fishery statistics until 1943, the entire catch of any vessel of U.S. registry landing more than one half of their catch in Alaska and B.C. ports was credited to Alaska, regardless of where the rest of the catch went or whether the remainder was credited to Alaska at a later port or not. This situation led to double-counting prior to 1943.

Other difficulties arise because, in general, data on catch and landing provided in sectional summaries of fishery statistics of the U.S. (under all three agencies) show halibut in round weights. In some years this is essentially the IPHC data transformed by a factor of 1.33. However, IPHC quotas reported catch and landings are all reported in dressed weight, which is the way the fishermen actually deliver the catch to port. The matter becomes still more confusing because in the early years of the fishery the livers and viscera had a value pound for pound twice that of the carcass. These organs were included both as part of the round fish reported and again in the processed section, sometimes mixed with other livers and viscera, which yielded different average weight entirely.

APPENDIX V

THE WORLD NOMINAL CATCH OF PACIFIC HALIBUT, ATLANTIC HALIBUT, AND GREENLAND HALIBUT BY COUNTRY AND YEAR, ACCORDING TO THE THE FOOD AND AGRICULTURE ORGANIZATION'S (FAO) YEARBOOKS OF FISHERY STATISTICS.

From 1970 on, nominal catches were expressed in metric tons. Before 1970, nominal catches were expressed in thousand metric tons. Figures have been converted to thousand metric tons, but digits to the right of the decimal have been retained. Before the late 1950s, landings were synonymous with nominal catch. The following symbols are used in the table to provide additional information on the possible measurement errors associated with nominal catch:

0	- More than 0 but less than .5 metric ton
00	- More than 0 but less than 50 metric tons
00.00	- More than 0 but less than 100 metric tons
--	- Nil, none
...	- Data not available or are unattainable. When used with a catch quantity, it is likely that the true value is different than shown, but is unavailable.
(Nominal catch)+	- The catch is as shown plus some quantity between 0 and .5 metric ton.
(Nominal catch)++	- The catch is as shown plus some quantity between 0 and 50 metric tons.

TABLE V-1

WORLD NOMINAL CATCH OF PACIFIC HALIBUT, HIPPOGLOSSUS STENOLEPIS, BY COUNTRY AND BY YEAR (IN THOUSANDS OF METRIC TONS)

Year	Canada [A]	U.S. [B]	USSR [C]	Japan
1977				
1976				
1975				
1974	4.188	8.289	.100	2.129...
1973	8.900	10.900	00	5.100++
1972	13.500	11.600	.800	5.900
1971	15.500	12.800	00	8.500
1970	18.100	15.600	00	6.800
1969	20.7	15.1	22.8	5.8
1968	17.9	11.7	26.9	5.9
1967	16.6	18.0	9.3	7.8++
1966	20.3	18.3	2.2	4.2
1965	20.2	18.4	1.8	3.6++
1964	19.9	15.9	2.5	...
1963	22.3	20.7	...	...
1962	20.7	24.4	...	...
1961	17.7	24.1	...	...
1960	15.4	23.1	...	...
1959	14.0	24.4	...	...
1958	13.1	21.7	...	...
1957	11.4	22.6	...	...
1956	11.5	25.0	...	...
1955	10.0	22.2	...	...
1954	12.4	27.5	...	...
1953	11.8	21.2	...	...

[A] Includes landings by British Columbia fishermen in the United States.

[B] Live Weight.

[C] Up to 1963, Pacific Halibut was included with "Various Teleostean Flatfishes".

TABLE V-2

CATCH OF GREENLAND HALIBUT, REINHARDTIUS HIPPOGLOSSOIDES, BY MAJOR COUNTRY AND YEAR (IN THOUSANDS OF METRIC TONS)

Year	Canada	Faeroes	German D.R.	F.R. Germany	Greenland	Iceland	Norway	Poland	USSR[A]	Wales England
1976										
1975										
1974	6.876	.600	35.017	2.564	4.036	2.841	8.923	13.793	54.791	4.774
1973	7.600	1.100	15.500	2.000	4.6++	2.100	15.300	14.400	37.100	5.300
1972	9.800	2.600	10.100	1.700	3.0++	4.600	17.600	23.000	37.500	4.400
1971	10.400	1.400	10.700	1.2++	1.2++	5.000	11.000	26.300	70.900	
1970	11.800	4.200	45.900	1.0++	1.200	7.300	16.200	29.400	46.300	
1969	13.600	1.9++	22.500	2.100	1.5++	5.900	15.600	10.800	38.900	
1968	14.100	00	10.200	2.100	1.6++	00	22.5++	5.800	27.800	
1967	16.700	00	7.900	4.700	1.800	00	17.5++	3.300	31.800	
1966	15.200	00	3.400	6.500	2.600	00	16.4++	1.100	10.300	
1965	9.400	00	3.900	5.900	3.000	00	18.1++	.600	19.100	
1964		00		4.100	2.700		14.200	1.800		
1963		.100		4.000	2.700		11.400	...		
1962		...		3.000	1.500		11.700	...		
1961		...		1.900	1.400		9.600	...		
1960		...		1.800	1.700		6.600			
1959		...		1.200	1.400		4.300			
1958		...		1.600	1.200		2.900			
1957					1.000		4.100			
1956					.800		3.500			
1955							3.000			
1954							3.700			

[A] The USSR has mixed Atlantic Halibut with Greenland Halibut.

[B] Unavailable prior to 1971.

TABLE V-3

CATCH OF ATLANTIC HALIBUT, <u>HIPPOGLOSSUS HIPPOGLOSSUS</u>, BY MAJOR COUNTRY AND YEAR (IN THOUSANDS OF METRIC TONS)

Year	Belgium	Denmark	Faeroes	F.R. Germ.	Iceland	Norway	Poland	Ro-mania	USSR[A]	U.K.	Canada	U.S.[B]
1976	0.030	0.062	0.389	0.502	1.697	1.621	0.016	--	.327	0.762	1.322	0.064
1975	0.043	0.062	0.295	0.550	1.190	1.506	0.005	--	.272	0.906	1.358	0.077
1974	0.049	0.050	0.300+	0.468	1.013	1.619	0.018	--	.218+	1.059	1.503	0.080
1973	0.100	0.100	0.3++	0.500	1.000	2.++	0.1++	0.100	.1...	1.2++	1.700	0.100
1972	0.100	0.100	0.3++	0.500	1.100	2.000	00.00	--	.1...	1.400	1.600	0.100
1971	0.100	0.100	0.3++	0.4++	1.300	2.500	0.1++	0.300	.2++	1.8++	2.000	0.100
1970	0.100	0.100	0.6++	0.5++	1.100	2.7++	00	0.100	...	1.5++	2.000	0.100
1969	0.100	0.100	0.200	0.6++	0.9++	2.800	0.100	--	...	1.7++	2.100	0.100
1968	0.200	0.100	0.300	0.700	1.1++	2.800	0.100	--	...	2.++	2.400	0.100
1967	0.200	0.100	0.3++	1.000	1.000	3.000	0.100	--	...	2.700	2.600	0.100
1966	0.200	0.100	0.2++	1.000	0.9++	2.800	0.200	--	...	2.800	3.000	0.100
1965	0.300	0.100	0.3++	1.200	1.++	3.900	0.400	--	...	3.500	2.700	0.100
1964	0.300	0.100	0.200	1.200	1.200	4.300	0.100	...	27.00	3.600	5.600	0.100
1963	0.400	0.100	0.200	1.200	1.200	4.500	00	...	3.500	3.400	4.600	0.100
1962	0.200	0.100	0.200	1.300	1.500	5.700	00	...	1.900	3.800	4.200	0.100
1961	0.400	0.100	0.300	1.700	1.800	5.200	00	...	4.000	4.300	4.400	0.100
1960	0.300	0.100	0.300	...	1.700	5.700	...	...	...	4.700	3.000	0.100
1959	0.300	0.100	0.500	...	1.200	5.200	...	...	...	4.400	2.900	0.100
1958	0.300	0.100	0.600	...	1.100	5.600	...	...	...	4.300	3.100	0.100
1957	0.200	0.100	0.400	2.300	1.100	4.300	...	...	...	3.900	3.400	0.200
1956	0.200	0.100	0.400	2.200	0.300	4.800	...	...	...	3.100	2.400	0.200
1955	0.100	00	--	1.800	0.300	4.400	...	...	...	3.300	2.000	0.100
1954	0.100	00	--	1.300	0.400	4.800	...	...	...	3.800	2.300	0.200
1953	0.100	00	--	1.200	0.500	4.100	...	...	...	4.400	2.000	0.200

A Russia includes Greenland Halibut with catches of Atlantic Halibut in 1970 and earlier years.

B Liveweight (round).

APPENDIX VI

SOME DIFFICULTIES IN MANAGING OCEAN FISHERIES AND THE ECONOMIC CONSEQUENCES OF A COMMON PROPERTY FISHERY

The Biological Side

The estimation of maximum sustainable yield (MSY) using classical population dynamics is a difficult and expensive process, especially in view of the various factors that the fisheries manager must consider. The definition of MSY is the maximum mortality due to fishing which will be produced in a long run equilibrium, holding constant effort, growth rate, food availability, natural mortality, etc.

Without any fishing pressure, all populations experience growth, and then, because of environmental constraints, the total biomass reaches maximum; that is, for another unit of time, the change in total biomass of the population would approach zero, if all other things were held constant. The dynamics of a fishery, however, involve a number of factors all working together simultaneously. Even in the absence of man, the idea of a population "in equilibrium" with its surroundings is little more than a theoretical starting point. It is conceivable that even unexploitable populations are never truly in "equilibrium", due to unobservable influences that cause population to fluctuate. The result of these influences may even change the characteristics of population growth. If there is one major difference between agriculture and fisheries, it is the degree to which managers in each sector have control over population parameters. These unobservable fluctuations in population caused by factors beyond human control affect the fishing industry, and the manner in which fishermen interact with the population. In the absence of perfect information on the causes of fish stock fluctuations, the values of MSY are themselves subject to changes in environmental factors, which implies not one value but a range of possible values. The objective of fisheries management appears to be the attempt to gain as much information as possible in a timely manner, and to make estimates of a sustainable and socially desirable yield that truly reflects the uncertainty that the fishery actually faces as a result of incomplete information.

However, the other half of the problem is that, in comparison to the slow, cumbersome methods of arriving at any sustainable yield estimates by classical technique for the exploited population, the movement of capital and labor into and out of a fishery can be almost mercurial in comparison. Although each point on the theoretical sustained yield curve is an equilibrium situation, there may be few cases of true equilibrium. For example, the original unit of effort in the halibut fishery was a skate of line that was hauled by hand, had fixed gangings and was fished from dories whose motherships were powered by sail or, at best, steam. In the early days of this fishery, harvesting went on practically year-round. Now, multipurpose boats are common, and diesel power is the standard propulsion system. Other new developments are electronic location, navigation and sensory equipment, snap-on gangings, automatic coilers, and improved deck layouts. Fishermen, because of their tendency to become more efficient producers, have changed the way they fish their gear and, in doing so, alter the fleet catch per unit effort values through time. Since IPHC uses catch per unit effort as an indirect measure of stock abundance, maximum sustainable yield may be overestimated if appropriate adjustments are not made in the data on catch and effort collected from the fishermen. These are just a few problems that estimates of MSY might include. Although MSY estimates are more applicable to longlived fish of high fecundity like halibut, to merely state that MSY might be obtained by taking an average of the best years of catch, assuming constant environmental and population conditions, may be true in theory, but it is misleading, if not erroneous, when working with empirical data.

The Economic Side

Crutchfield and Zellner's paper in 1963 on the Economic Aspects of the Halibut Fishery follows the analyses of Gordon (1954), Scott (1955), and Turvey and Wiseman (1957) by reiterating that those marine fisheries that are open to all fishermen (as the halibut fishery is) and are unregulated tend eventually toward overexploitation. In addition, both Chung (1972) and Crutchfield and Zellner (1963) imply that, without some restriction on the entry of fishing vessels, profits to fishermen that would occur as a result of a quota on the catch are dissipated through entry and increase in search costs, with a resultant rise in the cost structure for everybody in the fishery. These conditions are illustrated by the diagrams that closely follow Crutchfield and Zellner's paper (Figures VI-1 and VI-2). Figure VI-1 represents the amount supplied and demanded at each point on the equilibrium curve xx in response to different fish population levels. The economic and biological equilibrium obtained at S-OB and D_2 with price Y represents a maximum equilibrium yield, or MSY. Those equilibriums above this equilibrium in Figure VI-1 are those that lie within the area of overfishing.

Figure VI-2, after Crutchfield and Zellner, shows the effect of a management principal that advocates maximum sustainable yield as an objective. The supply and demand function, S_1 and D_1 in this case, begins with P_1 = Equilibrium yield at point A. If the aggregate demand for halibut, as represented through the processors' derived consumer demand for the input, is moved to D_2 through a change in consumer tastes and preferences or the population base, the equilibrium in an unregulated industry would dictate a quantity Q_2 at a price P. The quantity Q_1 to Q_2 is the amount by which the breeding stock is decreased. This would raise the cost of search by a further decrease in catch per unit effort and an increased entry into the fishery. In the unregulated fishery this has no equilibrium short of the economic extinction of the fishery (Crutchfield and Zellner 1963). However, the supply curve in a quota situation is transected at the MSY axis and assumes the vertical shape of MSY curve with a price P_2 at equilibrium. The result is an increased entry into the fishery in the next season in response to the good year before. Windfall profits in either case are summarily dissipated through a rise in the cost structure of the industry due to other stock depletion or the entry of new vessels (longlived and therefore a distributed impact through time) or vessels structured for entry into other fisheries.

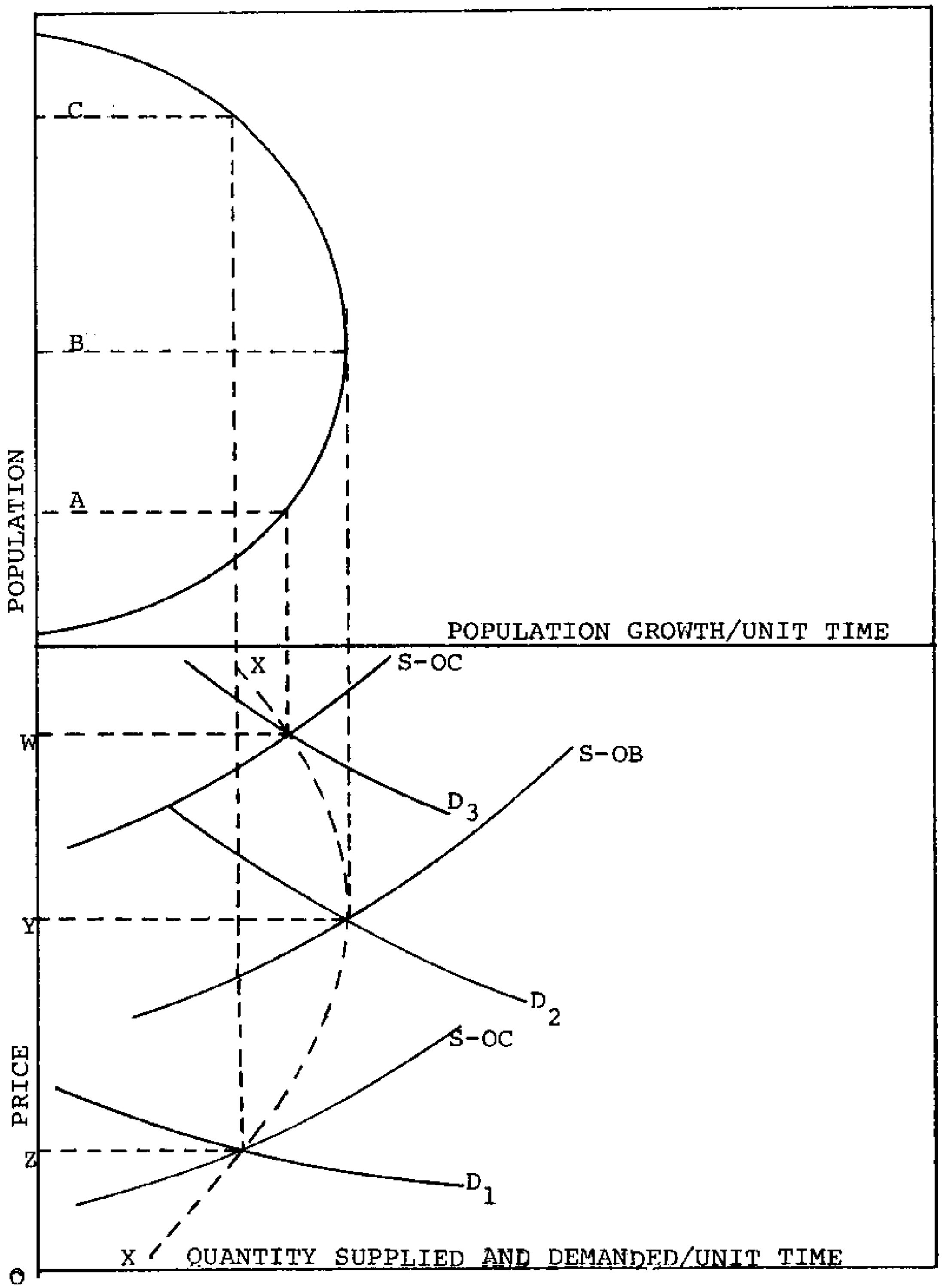


FIGURE VI-1. BIOLOGICAL AND ECONOMIC EQUILIBRIUMS IN AN UNREGULATED FISHERY. After Crutchfield and Zellner, 1963.

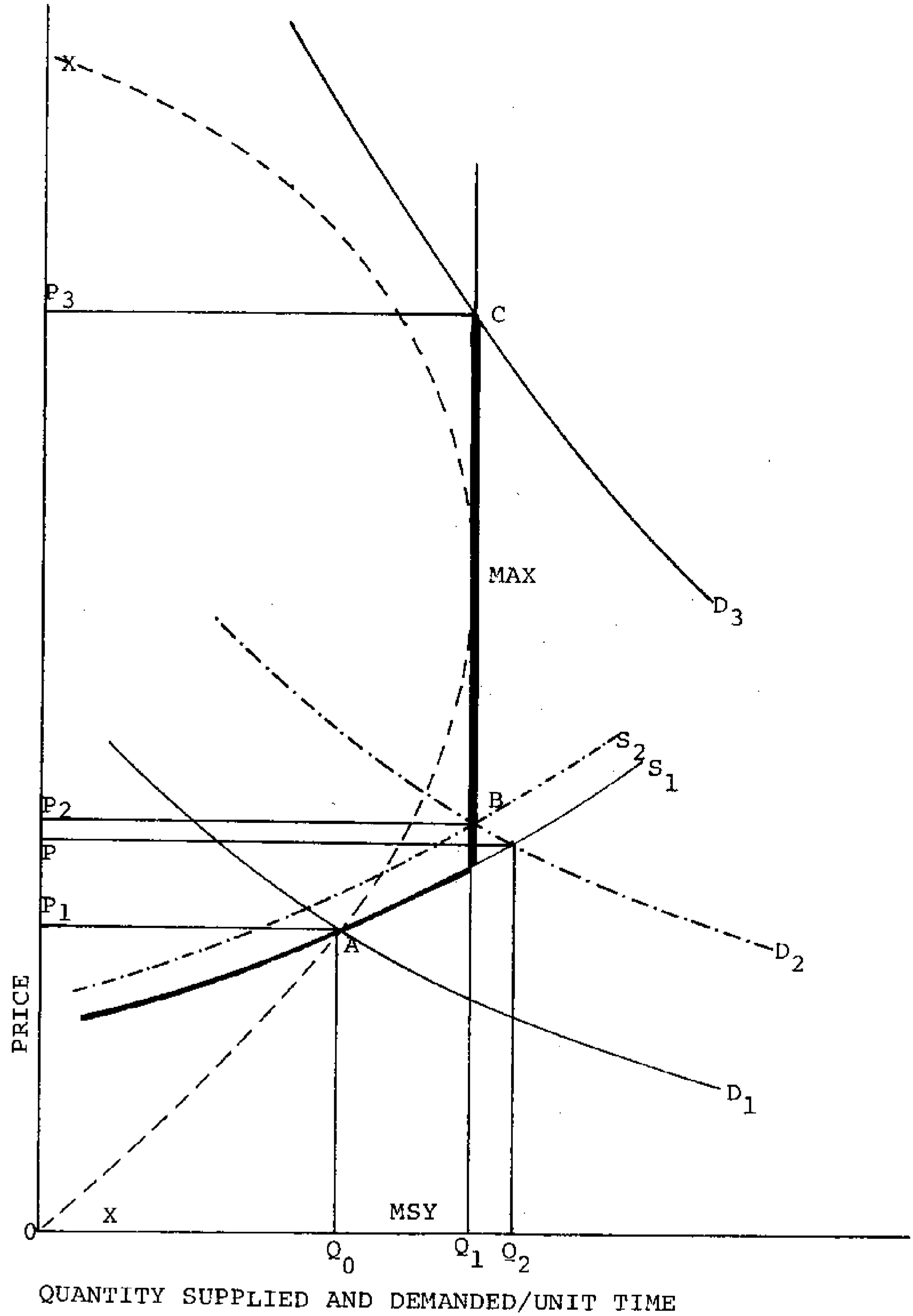


FIGURE VI-2. ECONOMIC EQUILIBRIUM IN A FISHERY WHERE MANAGEMENT OBJECTIVE IS MAXIMUM SUSTAINABLE YIELD.

Developments in Fisheries Management Techniques

With the foregoing pieces of information directly in hand it would be useful to look at fisheries management history and to make some observations about how management techniques have been changing.

Fisheries management has substantially changed since the late 1960s in two ways:

1. The manner in which they arrive at optimum levels of exploitation of a fishery.

2. The alternatives available to them in order to control the amount of capital and labor used in a fishery.

It seems clear that PL94265 (The Fishery Conservation and Management Act) entailed much more than simply the extension of the U.S. jurisdiction to 200 miles. The formation of the councils and the explicit directive by the act to consider allocations of fishing stock in light of not only biological optimums, but also social and economic optimums opened up new avenues of input into the decision making process of allocating fish resources. Instead of a single body of managers issuing a directive based on their findings of biological strength of an exploited stock, biological optimization has become one of, but not the only, criterion on which to allocate resources to users. Assessments of stock conditions, while becoming more innovative and timely sometimes diverge from classical population dynamics considerations. Researchers can many times disagree on stock strength even when using the same methods, indicating that considerable distance lies between what is discernable by present techniques and what actually goes on in wild populations. However, these changes in methods of monitoring and allocating stocks appear to be not worse than a system where interpretations of stock health are based solely on biological data. This is provided that changes in policy are made in small reversible increments, and that the planning and allocative machinery is sensitive enough to detect major changes in population parameters, as well as the structure and health of the fishing industry.

It is clear from writers in the field of natural resources economics that there could be a real problem with free entry and use of public goods. However, the methods by which control of exploitation can be exercised is the point of contention. Traditionally, in the U.S., it seems that the concept of self-determination exhibits itself, at least among fishermen, as the right to fish the common property; and the right of everyone else to try their hand at it too; and may the best person win. Some fishermen of long standing, who have nothing at all to lose (and substantially more to gain by advocating limited entry) have indicated that if left to them they would abolish limited entry. This could be interpreted as a statement of doctrine dating back to the Anglo-Saxon period (which have long since been incorporated in standard legal codes) that state, among other things, that all subjects of a sovereign (in our case, a sovereign state) have a right to enter and exploit any resource deemed "common property". Political and economic activity based upon its espousal is widespread in the U.S. not only in fisheries but in a host of other situations where public goods are involved. This and other major doctrines derived from Anglo-Saxon can inherently give preference to development over preservation: The restriction of gear and labor units is preferred to the limitation of entry into the exploitation of a resource. One has only to look at Alaska's decision to abolish cannery traps to see that the choice was in favor of widespread access by the general public, and restricted access of highly efficient gear types.

However, legal interpretations of these doctrines in some states have recently tended towards giving more power to decide the manner in which resources will be exploited back to the public (in this case our government) (Brion 1975). This concept of stewardship or "public trust" is being used to justify the intervention of state and federal government in decisions of how to best use public goods (Wilson 1977). These reinterpretations of common property doctrine justify the institution of limited entry. However, it appears that the recent political and social upheaval in Alaska revolves around the individual's interpretation of his rights based on the old commons doctrine or the stewardship doctrine. One group believes that everyone has a right to fish if he chooses. The logical conclusion is a greater willingness to accept gear restrictions in order to foster widespread employment. The other group believes that the state has the right to provide for the economic well being of her fishermen and the perpetuation of the resource by whatever means are moved upon by the due powers of government: in this case limited entry. These interpretations of basic rights are at the heart of the controversy with regard to limited entry. The consequences of choosing one or the other management techniques are far-reaching: one method (restrictions on efficiency) promises to give widespread employment with misallocation of resources for harvesting. The other management method (limited entry) promises to yield high efficiency, social inequity and the possibility of movement towards monopolistic competition, oligopoly or pure monopolism.

APPENDIX VII

THE RELATIONSHIP BETWEEN HOOK SPACING, SOAK TIME, AND CATCH IN THE HALIBUT FISHERY, AS REPORTED IN SCIENTIFIC REPORT NUMBER 56 (SKUD 1975)

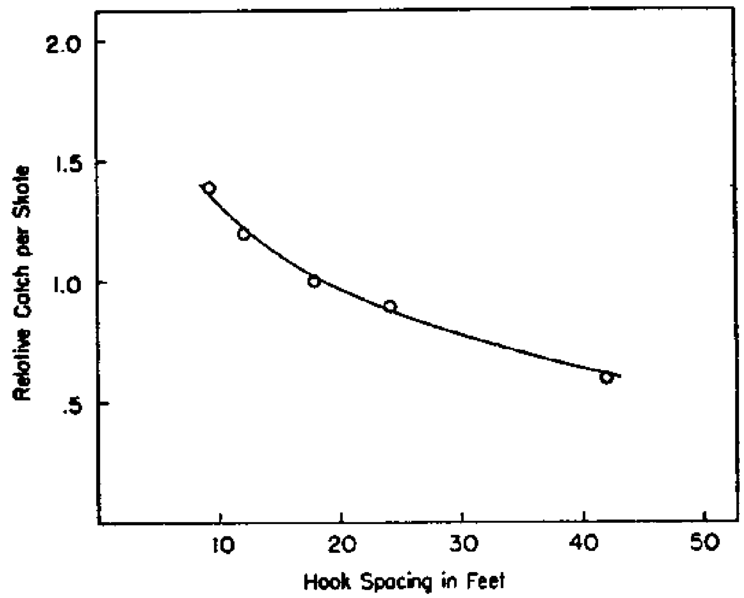


FIGURE VII-1. RELATION OF CATCH PER SKATE TO HOOK SPACING ON LONGLINE GEAR.

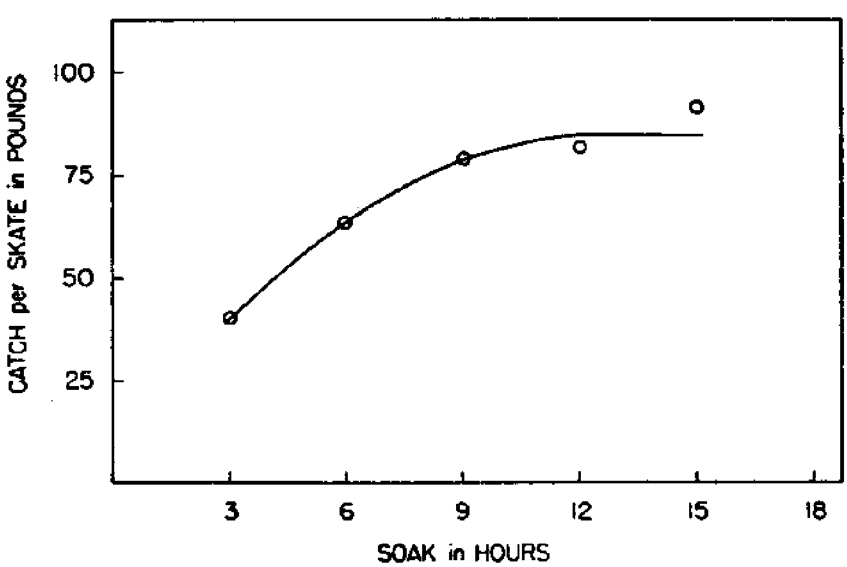


FIGURE VII-2. RELATION OF CATCH PER SKATE TO SOAK TIME.

APPENDIX VIII

PRODUCTION OF HALIBUT WITH TOTAL VALUES BY
MAJOR ALASKA REGION, 1950 TO 1976, AS REPORTED
BY ALASKA DEPARTMENT OF FISH AND GAME (ADF&G) CATCH
AND PRODUCTION STATISTICS

(One table)

TABLE VIII-1

PRODUCTION OF HALIBUT WITH TOTAL VALUES BY MAJOR ALASKA REGIONS 1950 TO 1976

Year	S.E. AK		CENTRAL		TOTAL	
Product Form	Product	Value	Product	Value	Product	Value
1950						
Fresh	3,832,364	892,651	12,277	2,028	3,844,641	894,679
Frozen	18,145,873	3,907,448	4,328,493	958,811	24,474,366	4,866,259
Fillets & steaks	129,922	28,896	39,092	11,466	169,014	40,362
Cheeks	2,161	1,081	--	--	2,161	1,081
Total	22,110,320	4,830,076	4,379,862	972,305	28,490,182	5,802,381
Livers	390,050	201,150	31,736	17,681	421,786	218,831
Viscera	457,569	56,795	32,257	3,889	489,826	60,684
1951						
Fresh	4,385,752	777,217	--	--	4,385,752	777,217
Frozen	14,723,398	2,540,976	3,834,911	645,908	18,558,309	3,186,884
Frozen cheeks	3,983	796	3,742	375	7,725	1,171
Total	19,113,133	3,318,989	3,838,653	646,283	22,951,786	3,965,272
Frozen livers	231,457	134,190	41,469	24,881	272,926	159,071
Frozen viscera	327,064	63,135	55,322	11,064	382,386	74,199
1952						
Fresh	3,036,870	605,008	160	51	3,037,030	605,059
Frozen	19,089,518	3,431,329	2,669,931	472,818	21,759,449	3,904,147
Frozen cheeks	9,359	3,502	2,515	503	11,910	4,005
Total	22,135,747	4,039,839	2,672,606	473,372	24,808,389	4,513,211
Frozen livers	281,822	125,677	26,732	9,528	308,554	135,205
Frozen viscera	440,878	78,682	33,932	3,545	474,810	82,227
1953						
Fresh	1,969,994	325,049	--	--	1,969,994	325,049
Frozen	14,274,314	2,164,860	3,663,204	609,278	17,937,518	2,774,138
Frozen cheeks	12,379	3,033	2,300	575	14,679	3,608
Frozen fillets	23,660	9,006	1,920	960	25,580	9,966
Total	16,280,347	2,501,948	3,667,424	610,813	19,947,771	3,112,761
Frozen livers	187,353	78,061	36,434	13,068	223,787	91,129
Frozen viscera	310,379	50,942	52,864	6,650	363,243	57,592
1954						
Fresh	4,235,570	732,930	194	78	4,235,764	733,008
Frozen	18,889,131	2,940,742	3,408,690	605,340	22,297,821	3,546,082
Frozen cheeks	22,760	6,627	3,079	770	25,839	7,397
Total	23,147,461	3,680,299	3,411,963	606,188	26,559,424	4,286,487
Livers	274,300	91,937	34,144	13,468	308,444	105,405
Viscera	430,297	79,603	47,734	6,304	478,031	85,907

TABLE VIII-1 (Continued)

Year	S.E. AK		CENTRAL		TOTAL	
Product Form	Product	Value	Product	Value	Product	Value
1955						
Fresh	2,751,165	364,878	--	--	2,751,165	364,878
Frozen	15,022,550	1,966,881	4,997,333	805,764	20,019,883	2,772,645
Frozen cheeks	15,168	3,942	3,700	925	19,318	4,867
Total	17,788,883	2,335,701	5,001,033	806,689	22,790,366	3,142,390
Livers	175,995	41,259	30,092	7,523	206,087	48,782
Viscera	215,986	26,131	34,837	2,902	250,823	29,033
1956						
Fresh	3,001,000	684,228	--	--	3,001,000	684,228
Frozen	19,308,468	3,882,701	3,150,506	632,610	22,458,974	4,515,311
Frozen cheeks	15,015	3,588	1,476	369	16,491	3,957
Total	22,324,483	4,570,517	3,151,982	632,979	25,476,465	5,203,496
Livers	85,664	34,079	1,920	764	87,584	34,843
Viscera	39,416	7,802	--	--	39,416	7,802
1957						
Fresh	122,242	19,800	--	--	122,242	19,800
Frozen	16,294,562	2,791,899	3,763,645	757,108	20,058,207	3,549,007
Frozen cheeks	2,160	648	2,255	564	4,415	1,212
Total	16,418,964	2,812,347	3,765,900	757,672	20,184,864	3,570,019
Frozen livers	101,949	35,767	1,930	500	103,879	36,267
Frozen viscera	123,049	25,164	--	--	123,049	25,164
1958						
Fresh	--	--	2,000	600	2,000	600
Frozen	17,464,164	3,904,426	5,078,024	1,060,630	22,542,188	4,965,056
Frozen cheeks	8,845	3,021	695	173	9,540	3,194
Total	17,473,009	3,907,447	5,080,719	1,061,403	22,553,728	4,968,850
Frozen livers	209,183	44,563	--	--	209,183	44,563
Frozen viscera	2,518	75	--	--	2,518	75
1959						
Fresh	--	--	3,243	810	3,243	810
Frozen	19,412,720	4,594,900	6,540,848	1,442,271	25,953,568	6,037,171
Frozen cheeks	8,765	3,037	458	160	9,223	3,197
Total	19,421,485	4,597,937	6,544,549	1,443,241	25,966,034	6,041,178
Frozen livers	68,386	15,060	--	--	68,386	15,060
Frozen viscera	16,782	671	--	--	16,782	671

TABLE VIII-1 (Continued)

Year Product Form	S.E. AK Product	S.E. AK Value	CENTRAL Product	CENTRAL Value	TOTAL Product	TOTAL Value
1960						
Fresh	--	--	1,524	380	1,524	380
Dressed frozen	16,441,747	2,839,635	6,490,718	868,452	22,932,465	3,708,105
Frozen cheeks	15,312	3,843	--	--	15,312	3,843
Total	16,457,059	2,843,478	6,492,242	868,832	22,949,301	3,712,328
Frozen livers	75,936	22,309	--	--	75,936	22,309
Frozen viscera	15,178	1,517	--	--	15,178	1,517
1961						
Fresh	--	--	1,100	330	1,100	330
Frozen Dressed	19,555,700	5,490,000	4,757,000	1,333,530	24,312,700	6,823,530
Frozen Fletches	370,800	198,200	--	--	370,800	198,200
Total	19,926,500	5,688,200	4,758,100	1,333,860	24,684,600	7,022,060
Frozen livers	40,200	11,640	--	--	40,200	11,640
Frozen viscera	14,100	1,410	--	--	14,100	1,410
1962						
Fresh	7,600	1,940	--	--	7,600	1,940
Frozen halibut	21,876,500	7,438,560	8,649,900	2,624,860	30,526,400	10,063,380
Frozen fletches	347,500	208,490	1,600	520	349,100	209,010
Frozen cheeks	25,800	9,610	--	--	25,800	9,610
Canned	--	--	1,000	810	1,000	810
Total	22,257,400	7,658,600	8,652,500	2,626,190	30,909,900	10,284,750
Livers/viscera	24,900	2,940	--	--	24,900	2,940
1963						
Fresh	--	--	--	--	--	--
Frozen	16,818,800	4,761,030	10,115,100	3,000,150	26,933,900	7,761,540
Frozen fletches	222,200	131,170	42,000	20,980	264,200	152,150
Frozen cheeks	19,700	7,290	--	--	19,700	7,290
Total	17,060,700	4,899,490	10,157,100	3,021,130	27,217,800	7,920,980
Livers/viscera	28,800	3,460	60,900	3,040	89,700	6,500
1964						
Fresh	--	--	47,100	10,870	47,100	10,870
Frozen dressed	14,456,900	5,498,720	6,860,700	2,333,240	21,317,600	7,831,960
Frozen fletches	200,900	134,810	10,800	2,900	211,700	137,710
Frozen cheeks	30,000	19,800	--	--	30,000	19,800
Total	14,687,800	5,653,330	6,918,600	2,347,010	21,606,400	8,000,340
Frozen livers/viscera	3,800	420	111,900	5,000	115,700	5,420

TABLE VIII-1 (Continued)

Year Product Form	S.E. AK Product	 Value	CENTRAL Product	 Value	TOTAL Product	 Value
1965						
Fresh	--	--				
Frozen dressed	13,908,143	5,454,817	9,473,662	4,060,900	23,381,805	9,515,717
Frozen fletches	3,868,543	2,161,547	22,725	11,362	3,891,268	2,172,909
Frozen cheeks	30,373	12,522	--	--	30,373	12,522
Canned Halibut	--	--	960	960	960	960
Canned smoked halibut	240	656	--	--	240	656
Total	17,807,299	7,629,542	9,497,347	4,073,222	27,304,646	11,702,764
Livers/viscera	2,928	351	230,517	11,525	233,445	11,876
Bait	1,245	124	--	--	1,245	124
1966						
Fresh	--	--	--	--	--	--
Frozen dressed	18,397,682	7,438,855	9,440,302	3,635,955	27,837,984	11,074,810
Cheeks	21,092	7,512	9,657	4,238	30,749	11,750
Canned Smoked	192	273	816	1,400	1,008	1,673
Total	18,418,966	7,446,640	9,450,775	3,641,593	27,869,741	11,088,233
Livers	3,266	489	--	--	3,266	489
Bait	90,000	9,000	106,503	10,650	196,503	19,650
1967						
Fresh/Frozen:						
Dressed	15,761,711	4,461,478	6,872,420	2,058,206	22,634,131	6,519,684
Fletches	688,255	483,326	236,439	165,507	924,694	648,833
Cheeks	16,978	7,102	26,505	10,602	43,483	17,704
Canned	96	209	9,072	14,880	9,168	15,089
Total	16,467,040	4,952,115	7,144,436	2,249,195	23,611,476	7,201,310
Bait	55,400	1,662	269,636	10,785	325,036	12,447
1968						
Fresh/Frozen:						
Dressed	5,653,186	1,709,019	3,683,585	1,259,615	9,336,771	2,968,634
Fillets	415,972	291,180	--	--	415,972	291,180
Cheeks/fletches	7,180	3,231	18,155	7,262	25,335	10,493
Canned	96	162	240	256	336	418
Total	6,076,434	2,003,592	3,701,980	1,267,133	9,778,414	3,270,725
Bait	--	--	160,615	3,212	160,615	3,212

TABLE VIII-1 (Continued)

Year / Product Form	S.E. AK Product	S.E. AK Value	CENTRAL Product	CENTRAL Value	TOTAL Product	TOTAL Value
1969						
Fresh/Frozen:						
Dressed	8,283,936	3,750,594	6,996,573	3,072,596	15,280,509	6,823,190
Cheeks/fletches	809,165	882,998	30,817	15,550	839,982	898,548
Total	9,093,101	4,633,592	7,027,390	3,088,146	16,120,491	7,721,738
Bait	375,974	17,376	199,567	4,036	575,541	21,412
1970						
Fresh dress	87,569	47,028	16,150	6,527	103,719	53,555
Frozen dress	10,032,942	4,183,828	12,068,364	5,878,626	22,101,306	10,062,454
Frozen cheeks/fletches	24,690	18,983	527,745	598,057	552,435	617,040
Total	10,145,201	4,249,839	12,612,259	6,483,210	23,309,895	10,733,049
1971						
Fresh dressed	1,995	1,995	10,846	5,253	12,841	7,248
Frozen dressed	8,474,503	3,444,089	11,488,278	5,803,572	19,962,781	9,247,661
Froz. cheeks/fletches	742,479	685,795	220,355	237,421	962,834	923,216
Total	9,218,977	4,131,879	11,719,479	6,046,246	20,938,456	10,178,125
1972						
Fresh dressed	--	--	1,085	760	1,085	760
Frozen dressed	6,896,911	4,986,264	14,217,570	10,258,859	21,114,481	15,245,123
Froz. cheeks/fletches	568,430	790,123	434,511	549,133	1,002,941	1,339,256
Total	7,465,341	5,776,387	14,653,166	10,808,752	22,118,507	16,585,139
1973						
Fresh dressed	78,326	68,680	786	563	79,112	69,243
Frozen dressed	6,913,798	6,457,017	11,234,918	9,930,233	18,185,771	16,426,158
Frozen cheeks/fletches	298,110	436,756	316,376	639,270	614,486	1,076,026
Total	7,290,234	6,962,453	11,552,080	10,570,066	18,879,369	17,571,427
1974						
Fresh dressed	6,033	4,975	26,369	25,819	32,402	30,794
Frozen dressed	6,183,366	5,577,628	6,086,524	5,551,699	12,283,974	11,139,322
Frozen cheeks/fletches	282,549	393,374	7,620	7,620	290,169	400,994
Total	6,471,948	5,975,977	6,120,513	5,585,138	12,606,545	11,571,110

APPENDIX IX

QUALITY CONTROL GUIDELINES FOR A HALIBUT PROCESSING LINE IN ALASKA

The following quality control guidelines were given to the author by the line manager of an Alaskan processing company. These guidelines, although specific to one firm, provide an insight to the general "state of the arts" of quality control in the production of halibut.

I. Unloading

Unloading is accomplished by lowering a sling into the hold of a vessel and filling it with halibut. The filled sling is then raised and transported to the dock and dumped on a receiving table.

Quality: Halibut are to be handled to avoid bruising. Any contamination of halibut in the hold will be reported to the foreman, quality assurance, and management. Possible contaminates are glass, oil and bilge water. A problem boat list will be maintained by the front dock foreman. All contaminated fish must be isolated.

General Sanitation: After unloading is completed, the sling will be high-pressure cleaned in a tote containing an iocide solution. The tote will be covered.

Personal Sanitation: Smoking, eating, and drinking will not be allowed during unloading. This applies only to employees.

Safety: Safe operation: The crane shall be operated in such a manner as to insure the safety of all persons in the area. A loaded sling shall not be moved until the unloading crew is clear.

II. Receiving:

Once fish are dumped on the receiving table, they are turned white side up and moved to the deheader. Gaff hooks are used to facilitate moving the fish.

Quality: Halibut will be handled in such a manner as to avoid bruising. Gaffing is restricted to the head, tail and fin area. Gaffing of the cheeks should be avoided whenever possible.

General Sanitation: The receiving, deheading, and sorting area will receive a high pressure cleanup just prior to processing and after each shift. All totes containing fish or heads will have a lid during high pressure cleaning.

Personal Sanitation: Hair nets will be worn by all persons working in the receiving, deheading and sorting areas. Workers must use dips and apron wash at the beginning of each shift and after each absence from their area. An iocide boot dip will be placed at the bottom of the stairs to the receiving table.

Safety: All persons working in the receiving area are required to wear hard hats.

III. Deheading, Sorting and Grading: Deheading is accomplished by a diagonal cut through the migrated eye towards the pectoral fin. The heads are collected in an aluminum tote for cheeking. Any remaining poke ice is removed and the fish are weighed, sorted, graded, and placed into appropriate totes.

Quality: All halibut shall be sorted by weight; 10 to 20, 20 to 40, 40 to 60, 60 to 80, and 80 pounds and heavier. After the fish are weighed they are placed into appropriate totes. A scale check is required at the beginning of each shift. The fish are also graded based on quality. Good quality fish are graded as #1, and #2 fish are somewhat lesser in quality. The following criteria are used:

1. Flea bites extending past the fin into the flesh.
2. Seal bites.
3. Badly bruised, soft or ragged fish.
4. Slight off odor but not decomposed fish.

All totes containing fish will be iced down if not slimed immediately. All incoming head totes will be iced down and numbered. First in first used. Head totes are to be aluminum and allow for drainage.

General Sanitation: All totes stored outside must be high pressured clean prior to use. All totes awaiting use may not be nested and must be stored under cover, either in the building or with a lid. One person will be assigned to high-pressure clean the tote before its reuse. This individual will also high-pressure clean the receiving, deheading, and sorting area during meal breaks. In addition, he will also clear-water clean these areas during breaks. All areas cleaned with high pressure must be rinsed free of soap.

Safety: The deheading machine will be locked during coffee breaks, meal breaks, and at the end of the shift. The key will be controlled by the front dock foreman except during operation.

IV. Sliming Table: The halibut are unloaded on the sliming table to be washed and cleaned. The white side is slimed with a nylon brush and the poke cleaned. The fish are then tagged according to size, placed on freezer racks, black side down and blast frozen.

Quality: Fish slimers should conduct an organoliptic evaluation of each fish and set questionable fish aside for further evaluation by a quality assurance officer. All slime should be removed from the white side of the fish and all extraneous matter removed from the poke. The fish should be placed on the freezer racks, black side down, and in such a manner as to avoid distortion during freezing.

General Sanitation: The sliming table and general area will receive a clear water rinse prior to processing and during coffee breaks. A high pressure cleaning is required during meal breaks.* All racks will receive a high pressure cleaning before reuse.* All utensils will be held in iocide during coffee and meal breaks.

* Brushing with T20X can be substituted for high pressure.

Personal Sanitation: Hair containment is to be practiced by all line workers. All rain gear will be hung up in the area provided. All workers are required to use the hand dip and apron wash after each absence from their posts.

V. Glazing and Weighing: After freezing, the halibut are removed from the racks and placed in wire baskets. The baskets are dipped in a tank containing a glazing solution. After glazing, the halibut are weighed and loaded into van.

Quality: One glaze check per day is required for each of the following weight categories: 10 to 20, 40 to 60, and 80 pounds and heavier. A glaze sheet will be provided, percent glaze will be calculated according to glaze sheet instruction. The glaze will be between 4 and 9 percent of body weight. Temperature of all halibut to be 5° F or below before removing from blast freezer.

Glazing Procedure: Frozen halibut will be immersed in the glaze tank, immediately returned to the surface and allowed to stand until the surface water on the fish has frozen. This can be determined by feel: the fish surface will change from a slick to a tacky feel when all the surface water has frozen. This process will be repeated four times.

Glaze Preparation:

A. Fill tank with cold water.
B. Fill drum three-fourths full of hot water.
C. Pour 100# Frodex slowly into hot water with continuous vigorous stirring.
D. When Frodex looks dissolved, pour the solution into the glaze tank.
E. For any Frodex left in bottom of garbage can, add hot water with stirring to dissolve it and then add it to the tank.
F. Add ice to the tank by sprinkling and stirring so the ice doesn't clump, until the ice no longer melts. The brine temperature must be 26° to 29° F.

Sanitation: All glaze baskets shall receive a clear water rinse before each shift and after each use. The glaze tank will be rinsed with clear water before the addition of the glaze solution. The glaze tank and all the baskets will receive high pressure cleaning after each shift.

Personal Sanitation: Hair nets or hats are to be worn by all persons working in glazing and weighing area. All raingear must be hung in the area provided. All persons are required to use the hand dip and apron wash at the beginning of each shift and after each absence from their post.

VII. Cheeking:

Procedure: Insert a short bladed, sharp knife near the right eye socket and using a circular motion, cut towards the left eye socket. There will be evident bone structure which is used as a guide for completing the circle. The flap of skin between the eye sockets is not cut. The cut portion is folded over and all dark or bloodied meat cut away. The remaining meat is then cut away from the skin leaving the skin flap attached. Care should be taken to remove as much meat as possible without cutting any skin.

Quality: All halibut heads are to be cheeked. In order to keep the cheeks of good quality, each tote must be iced heavily. If the cheeks are held overnight they must be layer iced.

All cheeks must be soaked in fresh water but for no more than 15 minutes.

No red spots or discolored cheeks are to be packed.

General Sanitation: The cheeking area will receive a clean water rinse at coffee break and high pressure cleaning at meal breaks. Brushing with T20X may be substituted for high pressure. No baskets, packaging material, or product will be placed on the floor. Iocide buckets will be placed on each side of the cheeking table. All utensils will be soaked in iocide five minutes before the start of each shift and during meal and coffee breaks.

Personal Sanitation: Personnel must wear hair nets. All personnel will use the iocide dip and apron wash at the beginning of each shift and after each absence from their post.

Fletching Procedure:

1. The fish is hung using chain wrapped around the tail, and is lifted up with an electric hoist.
2. The first cut is made by inserting the knife in the middle of the rail section and making a cut the length of the fish down the back bone.
3. The second cuts are made down the sides of the fish, adjacent to the fins taking care not to cut into the flesh. The purpose of this cut is to break the skin away from the flesh.
4. Next a cut is made about midway down in the skin that was just cut away from the fin. This cut is made to provide a hand hold.
5. Starting at the tail a cut is made the length of the fish cutting as near to the bone as possible. The meat will be separated from the bone leaving as little meat attached as possible. The end result will be one-fourth of the fish will be cut away from the bone but still attached at the tail end. The process is repeated again on both sides of the fish until all quarters are cut free but remain attached at the tail.
6. Cut the quarters off.
7. Each quarter is then attached to the skinning boat at the narrow or tail end with the skin side down. Using a skinning knife, cut into the narrow end through the flesh to the skin. The knife is then pulled through the length of the quarter taking care to remove all flesh without cutting into the skin.
8. The fletch is then placed on the cutting table where it is cut into smaller fletches of 16" lengths and 4" widths.
9. All red, brown, or discolored areas on the fletch must be trimmed off.

10. Place the fletches onto the freezer racks taking care to keep them straight and avoid having any portion of the fletch hang over the rack edge. Also, the fletches must not be placed so close that they touch or they will freeze together.

Quality: Halibut used for fletching must be of the best quality; marginal or soft fish should not be used.

General Sanitation: The fletching area will receive a clear water rinse at coffee breaks and a high pressure cleaning at meal breaks. Brushing with T20X may be substituted for high pressure. All baskets and packaging material will be kept off the floor. All bellies and trimmings will be weighed on a separate table. Under no circumstance will the packaged product touch the floor. All utensils will be soaked in iocide for five minutes at the beginning of each shift and held in iocide during coffee and meal breaks. Iocide buckets will be placed on each side of the tables.

Personal Sanitation: All persons are required to use the iocide dip and apron wash after each absence from their post. Hair nets will be worn.

APPENDIX X

HERRING PRODUCTION AS REPORTED BY ALASKA DEPARTMENT OF FISH AND GAME (ADF&G) STATISTICS FROM 1960 TO 1976, WITH WHOLESALE VALUE

(One table)

TABLE X-1

ALASKA'S HERRING PRODUCTION, AS REPORTED BY ADF&G STATISTICS
1960 TO 1976, WITH WHOLESALE VALUE

Year / Product Form	Southeast Alaska Pounds	Southeast Alaska Value	Central Alaska Pounds	Central Alaska Value	Western Alaska Pounds	Western Alaska Value	Total Pounds	Total Value
1960								
Fresh Bait	25,850	7,755					25,850	7,755
Frozen Bait	4,206,250	168,191					4,206,250	168,191
Meal	12,206,000	591,000					12,206,000	591,100
Oil	10,389,135	623,348					10,389,135	623,348
1961								
Fresh Bait			46,300	1,630			463,000	1,630
Frozen Bait	3,680,000	132,730					3,680,000	132,730
Meal	7,620,000	444,530					7,620,000	444,530
Oil	545,600	379,710					5,456,400	379,710
1962								
Fresh Bait	275,000	3,300	1,610	20			276,610	3,320
Frozen Bait	6,069,270	224,150					6,069,270	224,150
Roe on kelp	46,150	22,500					46,150	22,500
Meal	4,590,000	344,300					4,590,000	344,300
Oil	4,336,350	203,600					4,336,350	203,600
1963								
Frozen Bait	4,128,930	169,320					4,128,930	169,320
Roe on kelp	184,530	78,350					184,530	78,350
Meal	4,458,000	285,100					4,458,000	285,100
Oil	4,290,400	222,390					4,290,400	222,390
1964								
Frozen Bait	3,904,970	115,470	689,600	20,220			4,594,570	135,690
Roe on kelp	15,100	7,810					15,100	7,810
Roe	9,990	3,990					9,990	3,990
Cured roe on kelp	274,760	164,200					274,760	164,200
Cured roe			23,070	23,460			23,070	23,460
Meal	6,927,290	474,700	44,000	3,200			6,971,290	477,900
Oil	7,473,060	570,600					7,473,060	570,600

TABLE X-1 (Continued)

Year / Product Form	Southeast Alaska Pounds	Southeast Alaska Value	Central Alaska Pounds	Central Alaska Value	Western Alaska Pounds	Western Alaska Value	Total Pounds	Total Value
1965								
Bait	4,187,830	156,911	192,800	6,484			4,380,630	163,395
Roe on kelp	46,420	25,995					46,420	25,995
Cured roe on kelp	391,013	232,827					391,013	232,827
Cured roe	89,000	32,989	108,672	274,148			197,672	307,137
Meal	2,995,994	230,103	150,000	15,000			3,145,994	245,103
Oil	2,869,569	242,352					2,869,569	242,352
1966								
Frozen Bait	4,843,694	241,327	395,892	19,795			5,239,586	261,122
Cured roe on kelp	547,442	600,011	5,066	5,066			552,508	605,077
Cured roe	54,475	90,199	144,000	241,542			198,475	331,741
Meal	1,661,200	160,100	633,470	53,850			2,294,670	213,950
Oil	1,440,790	126,370	274,340	23,318			1,715,130	149,688
1967								
Bait	6,050,485	227,349	628,070	11,496			6,678,555	238,845
Cured roe			247,903	368,857	21,000	27,300	268,903	396,157
Cured roe on kelp	372,569	678,779	18,433	20,092			391,002	698,871
Meal			433,012	36,806			433,012	36,806
Oil			64,500	3,290			64,500	3,290
1968								
Fresh/ Frozen Bait	3,632,208	72,644	685,170	26,430			4,317,378	99,074
Cured roe on kelp	71,669	71,670			54,600	54,600	126,269	126,270
Cured roe	27,776	23,471	250,318	520,630			278,094	544,101
Meal			284,710	20,338			284,710	20,338

TABLE X-1 (Continued)

Year Product Form	Southeast Alaska Pounds	Southeast Alaska Value	Central Alaska Pounds	Central Alaska Value	Western Alaska Pounds	Western Alaska Value	Total Pounds	Total Value
1969								
Fresh/ Frozen Bait	5,288,753	230,856	253,339	16,162	328	16	5,542,420	247,034
Cured roe on kelp			5,449	8,336	9,138	13,981	14,587	22,317
Cured roe			199,575	322,406	900	900	200,475	323,306
Meal			141,971	11,356			141,971	11,356
1970								
Fresh Bait	1,000	900					1,000	900
Frozen Whole	333,200	19,973					333,200	19,973
Frozen Bait	6,412,150	265,353	72,983	4,361			6,485,133	269,714
Cured roe on kelp			46,033	45,921	33,520	13,408	79,553	59,329
Cured roe	26,330	42,420	224,354	373,214	1,345	2,085	252,029	417,719
Cured herring			7,040	1,600	6,860	1,509	13,900	3,109
Meal			56,600	5,238			56,600	5,238
1971								
Fresh Whole	1,123,176	77,000					1,123,176	77,000
Fresh Bait	140,000	1,752					140,000	1,752
Fresh roe					3,180	4,134	3,180	4,134
Frozen Whole	450,000	28,350					405,000	28,350
Frozen Bait	4,056,544	265,232	122,728	10,306			4,179,272	275,538
Cured roe on kelp			585,259	1,010,070	50,745	30,448	636,004	1,040,518
Cured roe	27,894	44,630	302,995	490,458			330,889	535,088
Meal			52,300	4,285			52,300	4,285
1972								
Fresh Whole								
Fresh Bait	43,721	15,302					43,721	15,302
Fresh roe								
Frozen Whole	1,907,310	167,649	28,248	49,420			1,935,550	217,069
Frozen Bait	4,957,658	300,278	375,744	36,105			5,333,402	336,383
Cured roe on kelp			560,150	846,769	60,000	27,000	620,150	873,769

TABLE X-1 (Continued)

Year Product Form	Southeast Alaska Pounds	Southeast Alaska Value	Central Alaska Pounds	Central Alaska Value	Western Alaska Pounds	Western Alaska Value	Total Pounds	Total Value
1972 (Continued)								
Cured roe			248,539	435,167	8,000	16,000	256,539	451,167
Meal			40,158	3,604			40,158	3,604
1973								
Frozen Whole	3,516,236	593,691	4,781,423	905,560			8,297,659	1,499,251
Frozen Bait	10,374,471	701,585	605,882	64,384	18,292	2,744	10,998,645	768,713
Cured roe on kelp			277,246	370,950	10,500	10,500	287,746	381,450
Cured roe	386,573	111,125	992,012	3,287,916			1,378,585	3,399,041
Meal			154,260	28,340			154,260	28,340
1974								
Fresh Whole	5,000	4,750	1,640,092	131,207			1,645,092	135,957
Fresh Bait	82,500	8,375					82,500	8,375
Frozen Whole	4,448,034	515,863	2,629,563	550,199	299,600	73,402	7,377,197	1,139,464
Frozen Bait	49,104,393	4,703,598	1,399,332	322,295	39,000	7,020	50,542,725	5,032,913
Cured herring			24,554	24,554			24,554	24,554
Cured herring roe	2,184,825	527,248	749,641	1,871,128	1,542,654	340,434	4,477,120	2,738,810
Cured roe on kelp			988,453	523,437	110,729	116,814	1,099,182	640,251
Meal			141,400	23,418			141,400	23,418
1975								
Fresh/Frozen Whole/Dressed	7,149,381	704,505	5,788,923	995,906	69,720	13,805	13,008,024	1,714,216
Fresh/Frozen Bait	1,444,723	184,636					1,444,723	184,636
Fresh/Frozen roe			28,664	72,000			28,664	72,000
Fresh/Frozen roe on kelp			142,227	193,480			142,227	193,480
Cured Whole/ Dressed			10,320	19,917			10,320	19,917

TABLE X-1 (Continued)

Year / Product Form	Southeast Alaska		Central Alaska		Western Alaska		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1975 (Continued)								
Cured roe	47,737	31,900	1,449,370	3,704,843	80,000	11,000	1,577,107	3,747,743
Cured roe on kelp			725,138	1,041,066	36,695	36,695	761,833	1,077,761
Meal								
1976								
Bait	3,718,906	398,538	15,373	2,106			3,734,279	400,644
Roe	1,576,036	717,937	1,080,174	2,924,520			2,656,210	3,642,457
Herring	2,415,357	538,889	2,202,471	690,887			4,617,828	1,229,776
Roe on kelp	31,311	96,074	203,010	330,199	105,545	192,378	339,866	618,651
Meal			638,600	110,478			638,600	110,478

APPENDIX XI

YEARLY CATCH OF ENGRAULIS SP. AND CENTENGRAULIS SP. (ANCHOVY) AND BREVOORTIA SP. (MENHADEN) AS RECORDED BY FOOD AND AGRICULTURAL ORGANIZATION (FAO) FISHERY STATISTICS

TABLE XI -1

YEARLY CATCH OF ENGRAULIS SP. AND CENTENGRAULIS SP. (ANCHOVY) AS RECORDED BY FAO FISHERY STATISTICS

(In Thousands of Metric Tons)

Year	E. Ringens		E. Encrasicolus	E. Japonicus	E. Mordax	E. Anchoita	E. Capensis	Other Anchovies	C. Mysticetus	% of World Clupeid Catch
	Chile	Peru								
1938	1.4	---	100.0	---	1.0					2.13
1948	0.9	Ø	128.0	---	5.0					2.84
1958	39.5	737	181.0	463.0	5.0					19.47
1961	259.1	5010.9	257.0	418.0	4.0					47.40
1962	435.0	6691.5	255.0	408.0	1.0					53.03
1963	539.4	6634.8	285.0	392.0	2.0					52.56
1964	934.0	8863.4	300.0	423.0	2.0					56.66
1965	438.5	7242.4	338.1	473.4	2.6	16.6	178.3	58.1	42.3	52.16
1966	1098.8	8529.8	331.5	485.7	28.3	11.0	159.9	64.2	66.5	57.35
1967	705.4	9824.6	343.7	456.4	31.6	13.4	297.5	73.0	60.5	60.04
1968	1019.4	10262.7	318.0	430.0	14.3	32.2	331.0	63.8	68.9	61.28
1969	750.8	8960.5	245.0	502.1	61.5	15.5	397.4	72.8	12.6	60.83
1970	782.9	12277.0	327.6	429.9	87.5	13.6	403.7	65.8	33.6	67.47
1971	966.9	10276.8	332.3	428.3	40.0	20.5	394.5	59.5	57.8	64.72
1972	966.9	4447.8	305.4	475.3	77.6	41.1	416.8	84.5	19.5	50.49
1973	191.8	1513.0	382.4	430.9	128.1	34.3	579.6	149.3	59.9	30.66
1974	383.4	3583.5	599.9	461.0	157.3	30.4	598.2	276.3	15.6	43.96
1975	239.8	3078.8	458.9	420.6	209.7	19.2	448.1	212.5	45.3	37.69
1976	413.0	3863.1	487.5	343.0	196.0	20.4	306.7	266.7	121.5	39.88

[1] Some figures have been estimated by FAO. Common names and scientific names of the species are listed below.

Engraulis ringens - Peruvian Anchovy - Anchoveta
Engraulis encrasicolus - European Anchovy
Engraulis japonicus - Japanese Anchovy
Engraulis mardox - North Pacific Anchovy
Engraulis anchoita - Argentina Anchovy
Engraulis capensis - Cape Anchovy
Centengraulis mysticetus - Central Pacific Anchovy

TABLE XI-2

ANNUAL CATCH OF MENHADEN (BREVOORTIA SP.)
BY COUNTRY IN THOUSAND METRIC TONS AS RECORDED BY FAO

(In Thousands of Metric Tons)

Year	U.S.[1]	Brazil	Chile	Peru	Argentina	Uruguay	% Total U.S.
1938	234.7						∿100
1948	457.2						∿100
1958	702.7						∿100
1961	1049.9	3.0					99.9
1962	1065.0	1.2					99.9
1963	823.6						∿100
1964	710.7						∿100
1965	782.9		.1	7.0			99.1
1966	593.2		.2	13.4			97.8
1967	527.9		.3	18.4			96.6
1968	623.7		.1	11.9			98.1
1969	701.0		.2	13.0			98.2
1970	833.5		.7	19.7			97.6
1971	993.4		.4	22.8			97.7
1972	879.4		.4	42.1			95.4
1973	856.3	10.8	2.1	44.7	.6	--	93.6
1974	897.7	6.5	.6	16.7	1.7	--	97.2
1975	819.8	7.2	.7	3.0	.1	.4	98.6
1976	925.1	8.1	.5	2.7	.5	.2	98.7

[1] The U.S. totals include the species *B. tyrannus* and *B. patronus*. In addition to the U.S. catch, Bulgaria, USSR and in 1975, Japan caught small amounts (100 mt or less) of Menhaden.

APPENDIX XII

PRODUCTION OF SOYBEAN MEAL, CAKE AND OIL WITH REPRESENTATIVE PER UNIT PRICES, SUPPORT PRICE OF SOYBEANS, AND PERCENTAGE PLACED UNDER SUPPORT PRICE, BY YEAR

(One table)

TABLE XII-1

PRODUCTION OF SOYBEAN MEAL, CAKE, AND OIL WITH REPRESENTATIVE PER UNIT PRICES, SUPPORT PRICE OF SOYBEANS AND PERCENTAGE PLACED UNDER SUPPORT PRICE, BY YEAR

Year	Meal 1000 Tons	$/Ton[1]	Oil Million Pounds	¢/Pound[2]	Farm Level Support Price $/Bushel	% Production Put Under Support
1939	1,349	23.05	533	7.5		
1940	1,543	24.40	564	9.9		
1941	1,845	35.00	707	14.6		
1942	3,200	35.75	1,206	14.8		
1943	3,446	45.00	1,219	15.1		
1944	3,698	45.00	1,347	15.3		
1945	3,837	55.25	1,415	16.0		
1946	4,086	72.30	1,531	28.6		
1947	3,833	80.80	1,534	29.5		
1948	4,330	66.10	1,807	18.5		
1949	4,586	64.30	1,937	16.6	2.11	6.9
1950	5,897	64.45	2,454	23.6	2.06	5.0
1951	5,704	83.35	2,444	16.6	2.45	3.9
1952	5,551	67.55	2,536	18.6	2.56	4.7
1953	5,051	78.65	2,350	19.0	2.56	11.8
1954	5,705	60.70	2,711	18.8	2.22	12.1
1955	6,546	52.55	3,143	18.7	2.04	8.1
1956	7,509	47.45	3,431	18.3	2.15	14.6
1957	8,284	53.40	3,800	16.6	2.09	18.7
1958	9,490	55.80	4,251	14.8	2.09	24.2
1959	9,152	55.55	4,338	10.1	1.85	9.8
1960	9,452	60.60	4,420	13.1	1.85	4.6
1961	10,342	63.60	4,790	11.4	2.30	19.5
1962	11,127	71.25	5,091	11.1	2.25	10.3
1963	10,609	71.00	4,822	10.7	2.25	10.4
1964	11,286	72.20	5,146	13.4	2.25	4.1
1965	12,901	81.50	5,800	13.6	2.25	10.2
1966	13,483	78.80	6,076	12.4	2.50	16.5
1967	13,660	76.90	6,032	10.5	2.50	20.6
1968	14,581	74.10	6,531	10.4	2.50	30.8
1969	17,596	78.40	7,904	13.1	2.25	15.9
1970	18,035	78.50	8,265	14.6	2.25	13.0
1971	17,024	90.20	7,892	12.7	2.25	14.3
1972	16,708	229.00	7,501	17.7	2.25	7.1
1973	19,674	146.30	8,995	33.0	2.25	8.0
1974	16,702	131.70	7,375	33.1	2.25	2.8
1975	20,754	147.80	9,630	23.5	----[3]	----

Source: Agricultural Statistics 1962, 1965 and 1977.

[1]Price for 1 ton soybean meal 44% protein at Decatur Ill.
[2]Price per pound of soybean oil at New York. From 1959 on prices are quoted for edible grade oil in tank storage. Before 1959 prices were established for oil in drums.
[3]No support price in 1975.

APPENDIX XIII

COMMERCIAL SALMON CATCH IN THE NORTH PACIFIC BY SPECIES AND BY COUNTRY, 1952 TO 1976

(One table)

TABLE XIII-1

COMMERCIAL SALMON CATCH IN THE NORTH PACIFIC
BY SPECIES AND BY COUNTRY, 1952 TO 1976
(In Thousands of Metric Tons)

Country & Species	1952	1953	1954	1955	1956	1957	1958	1959	1960
All Species	376.0	458.5	415.9	529.4	507.8	514.1	477.0	415.6	360.6
Canada	68.4	86.3	82.2	60.9	52.9	61.5	83.9	49.6	35.1
Japan	38.5	44.2	78.6	172.5	152.5	184.0	199.0	181.0	148.6
U.S.A.	152.7	139.2	144.1	131.4	142.4	120.6	123.5	90.8	107.4
U.S.S.R.	116.4	188.8	111.0	164.6	160.0	148.0	70.6	94.2	69.5
Sockeye	71.9	61.2	75.6	62.1	76.7	82.9	91.2	57.6	84.8
Canada	14.0	16.0	21.3	7.6	9.8	7.1	33.6	8.2	7.0
Japan	1.5	3.8	9.2	25.8	20.1	42.6	25.6	19.7	30.6
U.S.A.	47.2	36.3	41.1	25.6	41.1	29.7	31.0	25.7	43.2
U.S.S.R.	9.2	5.1	4.0	3.1	5.7	3.5	1.0		
Pink	139.5	235.6	120.4	251.0	200.3	261.4	188.1	190.6	112.1
Canada	23.3	28.0	11.7	28.7	13.1	26.0	15.4	15.9	7.7
Japan	25.7	21.6	25.3	74.7	71.6	95.9	91.6	101.3	60.8
U.S.A.	32.6	43.7	37.2	59.3	43.5	33.1	42.7	26.3	24.0
U.S.S.R.	57.9	142.3	46.2	88.3	72.1	106.4	38.4	47.1	19.6
Chum	106.3	106.9	163.8	152.0	169.2	122.0	142.9	119.5	125.2
Canada	14.5	24.7	33.7	8.2	12.4	12.4	17.3	10.5	9.2
Japan	11.2	18.1	40.9	62.6	51.4	44.5	70.2	53.3	50.1
U.S.A.	36.6	30.1	36.6	15.6	28.1	33.1	27.7	17.5	22.6
U.S.S.R.	44.0	34.0	52.6	65.6	77.3	32.0	27.7	38.2	43.3
Coho	33.6	29.9	33.0	38.3	36.9	27.9	35.4	27.8	20.6
Canada	10.1	10.5	9.4	10.7	11.4	10.3	11.2	8.9	6.5
Japan	.1	.7	2.9	9.1	9.0	.9	11.2	6.2	6.0
U.S.A.	18.8	12.2	13.2	12.2	12.7	11.5	10.2	8.8	6.2
U.S.S.R.	4.6	6.5	7.5	6.3	3.8	5.2	2.8	3.9	1.9
Chinook	24.7	24.9	23.1	26.0	24.7	19.9	19.4	20.1	17.9
Canada	6.5	7.1	6.1	5.7	6.2	5.7	6.4	6.1	4.7
Japan	0.05	0.05	0.3	0.3	0.4	0.1	0.4	0.5	1.1
U.S.A.	17.5	16.9	16.0	18.7	17.0	13.2	11.9	12.5	11.4
U.S.S.R.	0.7	0.9	0.7	1.3	1.1	0.9	0.7	1.0	1.0

TABLE XIII-1 (Continued)

Country & Species	1961	1962	1963	1964	1965	1966	1967	1968	1969
All Species	437.6	398.1	416.7	383.7	429.0	438.1	391.7	383.4	375.0
Canada	56.7	76.0	56.1	58.5	43.1	76.5	62.9	82.6	37.8
Japan	158.3	118.9	150.6	120.0	149.2	128.1	151.4	115.4	143.3
U.S.A	142.9	142.5	128.9	160.0	149.1	176.2	98.6	149.2	118.5
U.S.S.R.	79.7	60.7	81.1	45.2	87.6	56.3	78.8	36.2	75.4
Sockeye	103.8	64.9	46.8	53.4	103.2	78.3	85.2	68.2	61.5
Canada	12.1	9.1	5.4	10.4	7.4	11.7	16.8	18.8	10.9
Japan	36.7	24.8	19.1	14.3	25.0	16.6	35.4	22.4	15.5
U.S.A.	47.2	26.3	18.9	26.0	66.6	46.3	30.0	24.8	33.5
U.S.S.R.	7.8	4.7	3.4	2.7	4.2	3.7	3.0	2.2	1.6
Pink	179.0	163.9	205.7	142.4	161.4	174.7	169.4	156.7	195.3
Canada	22.7	42.5	27.5	16.7	10.4	33.3	23.4	25.2	6.3
Japan	75.9	40.4	75.2	38.1	66.9	46.7	71.6	47.7	74.5
U.S.A.	50.1	64.7	67.3	73.0	36.2	74.0	23.7	67.5	51.1
U.S.S.R.	30.3	16.3	35.7	14.6	47.9	20.7	50.7	16.3	63.4
Chum	106.1	113.6	104.4	119.3	98.6	119.9	81.3	96.2	65.3
Canada	6.6	8.2	7.0	10.9	3.0	7.0	5.5	16.6	6.1
Japan	40.9	44.3	46.1	53.1	49.1	59.7	39.6	38.3	39.6
U.S.A.	22.2	27.1	17.7	29.9	15.0	25.6	15.6	27.6	11.1
U.S.S.R.	36.4	34.0	33.6	25.4	31.5	27.6	20.6	13.7	5.9
Coho	30.6	37.8	40.8	45.5	43.9	44.3	34.8	41.2	30.7
Canada	11.2	12.1	11.6	14.4	16.6	17.5	10.2	15.1	8.0
Japan	4.3	8.4	9.5	12.5	7.2	4.7	3.8	5.6	9.6
U.S.A.	10.6	12.6	12.3	17.5	17.2	18.8	17.2	17.3	9.8
U.S.S.R.	4.5	4.7	7.4	1.1	2.9	3.3	3.6	3.2	3.3
Chinook	18.1	17.9	19.0	23.1	21.9	20.9	21.0	21.1	22.2
Canada	4.1	4.1	4.6	6.1	5.7	7.0	7.0	6.9	6.5
Japan	0.5	1.0	0.7	2.0	1.0	1.2	1.2	1.4	1.5
U.S.A.	12.8	11.8	12.7	13.6	14.1	11.7	11.7	12.0	13.0
U.S.S.R.	0.7	1.0	1.0	1.4	1.1	1.0	1.0	0.8	1.2

TABLE XIII-1 (Continued)

Country & Species	1970	1971	1972	1973	1974	1975	1976
All Species	417.3	433.9	326.4	393.7	328.1	384.5	389.0
Canada	72.5	63.1	76.7	86.3	63.4	36.3	57.4
Japan	119.8	141.7	118.4	131.9	129.6	155.5	122.3
U.S.A.	185.9	151.6	98.2	98.8	87.1	89.7	138.8
U.S.S.R.	39.1	77.5	33.1	76.7	48.0	103.0	70.5
Sockeye	116.9	84.3	43.5	55.6	55.4	38.5	60.0
Canada	11.4	17.3	9.5	21.5	21.7	5.7	12.3
Japan	28.6	16.7	11.0	9.4	8.2	7.7	8.8
U.S.A.	72.4	48.1	21.9	23.0	24.5	23.7	37.7
U.S.S.R.	4.5	2.2	1.1	1.7	1.0	1.4	1.2
Pink	132.0	181.6	96.3	150.8	92.5	169.7	145.2
Canada	24.0	17.6	18.1	13.3	11.2	10.2	17.1
Japan	38.6	60.5	32.3	50.1	32.3	45.6	29.4
U.S.A.	53.2	45.1	25.1	22.4	16.9	25.5	45.0
U.S.S.R.	16.2	58.4	20.8	65.0	32.1	88.4	53.7
Chum	100.8	98.5	128.7	122.8	117.7	121.3	119.6
Canada	16.8	5.4	30.2	32.7	12.5	5.4	10.9
Japan	45.6	56.7	66.4	60.6	77.5	92.9	74.8
U.S.A.	26.0	25.9	24.7	23.9	18.5	15.3	23.9
U.S.S.R.	12.4	10.5	7.4	5.6	9.2	7.7	10.0
Coho	43.3	43.6	33.6	38.9	40.3	31.7	37.9
Canada	13.7	14.1	10.5	11.2	10.4	7.7	9.3
Japan	5.4	6.8	7.5	10.6	9.7	8.2	7.7
U.S.A.	19.6	13.3	13.7	14.9	16.3	12.5	17.3
U.S.S.R.	4.6	4.4	1.9	2.2	3.9	3.3	3.6
Chinook	24.3	25.9	24.3	25.6	22.2	23.3	26.3
Canada	6.6	8.7	8.4	7.6	7.6	7.3	7.8
Japan	1.6	1.0	1.2	1.2	1.9	1.1	1.6
U.S.A.	14.7	14.2	12.8	14.6	10.9	12.7	14.9
U.S.S.R.	1.4	2.0	1.9	2.2	1.8	2.2	2.0

Source: Secretariat International North Pacific Fisheries Commission, Historical Catch Statistics for Salmon of the North Pacific Ocean. (Unpublished Report)

[1]F.A.O. figures for Canada for 1972 and 1973 do not agree with Canadian production figures (assuming landed rather than round weight used). (Japanese totals have been adjusted by species for some years.)

APPENDIX XIV

TOTAL LANDINGS OF SALMON IN THE PACIFIC AREA
BY SPECIES SHOWING TOTAL AND PERCENTAGE LANDED
IN U.S. AND CANADA, FROM 1952 TO 1976

TABLE XIV-1

TOTAL LANDINGS OF COHO SALMON IN PACIFIC AREA
SHOWING TOTAL AND PERCENTAGE LANDED IN
U.S. AND CANADA, 1952 TO 1976
(In Thousands of Metric Tons)

	Canada		U.S.		Total Pacific	Canada U.S. as % of Total
Year	Metric Tons	%	Metric Tons	%	Metric Tons	%
1952	10.1	30.1	18.8	55.9	33.6	86.0
1953	10.5	35.1	12.2	40.8	29.9	75.9
1954	9.4	28.5	13.2	40.0	33.0	68.5
1955	10.7	27.9	12.2	31.9	38.3	59.8
1956	11.4	30.9	12.7	34.4	36.9	66.3
1957	10.3	36.9	11.5	41.2	27.9	78.1
1958	11.2	31.6	10.2	28.8	35.4	60.4
1959	8.9	32.0	8.8	31.7	27.8	63.7
1960	6.5	31.6	6.2	30.1	20.6	61.7
1961	11.2	36.6	10.6	34.6	30.6	71.2
1962	12.1	32.0	12.6	33.3	37.8	65.3
1963	11.6	28.4	12.3	30.2	40.8	58.6
1964	14.4	31.7	17.5	38.4	45.5	70.1
1965	16.6	37.8	17.2	39.2	43.9	77.0
1966	17.5	39.5	18.8	42.4	44.3	81.9
1967	10.2	38.3	17.2	49.4	34.8	78.7
1968	15.1	36.7	17.3	42.0	41.2	78.7
1969	8.0	26.1	9.8	31.9	30.7	58.0
1970	13.7	31.6	19.6	45.3	43.3	76.9
1971	14.1	32.3	18.3	42.0	43.6	74.3
1972	10.5	31.3	13.7	40.8	33.6	72.1
1973	11.2	28.8	14.9	38.3	38.9	67.1
1974	10.4	25.8	16.3	40.4	40.3	66.3
1975	7.7	24.3	12.5	39.4	31.7	63.7
1976	9.3	24.5	17.3	45.6	37.9	70.2

Source: Yearbook of Fishery Statistics - Catches and Landings, F.A.O. (1958-1973); Historical Catch Statistics for Salmon of the North Pacific Ocean, International North Pacific Fisheries Commission (Unpublished Report); Catch Data from John West Limited, England, 1952-1974.

TABLE XIV-2

TOTAL LANDINGS OF SOCKEYE SALMON IN PACIFIC AREA SHOWING TOTAL AND PERCENTAGE LANDED IN U.S. AND CANADA, 1952 TO 1976
(In Thousands of Metric Tons)

	Canada		U.S.		Total Pacific	Canada & U.S. as % of Total
Year	Metric Tons	%	Metric Tons	%	Metric Tons	%
1952	14.0	19.5	47.2	65.6	71.9	85.1
1953	16.0	26.1	36.3	59.4	61.2	85.5
1954	21.3	28.2	41.1	54.3	75.6	82.5
1955	7.6	12.2	25.6	41.4	62.1	53.6
1956	9.8	12.8	41.1	53.6	76.7	66.4
1957	7.1	8.6	29.7	35.8	82.9	44.4
1958	33.6	36.8	31.0	34.0	91.2	70.8
1959	8.2	14.2	25.7	44.7	57.6	58.9
1960	7.0	8.3	43.2	50.9	84.8	59.2
1961	12.1	11.7	47.2	45.4	103.8	57.1
1962	9.1	14.0	26.3	42.1	64.9	56.1
1963	5.4	11.5	18.9	40.4	46.8	51.9
1964	10.4	19.5	26.0	43.5	53.4	63.0
1965	7.4	7.2	66.0	63.5	103.2	70.7
1966	11.7	14.9	46.3	59.1	78.3	74.0
1967	16.8	19.7	30.0	35.2	85.2	57.3
1968	18.8	27.6	24.8	36.3	68.2	63.9
1969	10.9	17.7	33.5	54.5	61.5	72.2
1970	11.4	9.8	72.4	61.9	116.9	71.7
1971	17.3	20.6	48.1	57.0	84.3	77.6
1972	9.5	21.8	21.9	50.3	43.5	72.1
1973	21.5	38.7	23.0	41.4	55.6	80.0
1974	21.7	39.2	24.5	44.2	55.4	83.4
1975	5.7	14.8	23.7	61.6	38.5	76.4
1976	12.3	20.5	37.7	62.8	60.0	83.3

Source: Yearbook of Fishery Statistics - Catches and Landings, F.A.O. (1958-9773); Historical Catch Statistics for Salmon of the North Pacific Ocean, International North Pacific Fisheries Commission (Unpublished Report); Catch Data from John West Limited, England, 1952-1974.

TABLE XIV-3

TOTAL LANDINGS OF PINK SALMON IN PACIFIC AREA
SHOWING TOTAL AND PERCENTAGE LANDED IN
U.S. AND CANADA, 1952 TO 1976
(In Thousands of Metric Tons)

	Canada		U.S.		Total Pacific	Canada & U.S. as % of Total
Year	Metric Tons	%	Metric Tons	%	Metric Tons	%
1952	23.3	16.7	32.6	23.4	139.5	40.1
1953	28.0	11.9	43.7	18.5	235.6	30.4
1954	11.7	9.7	37.2	30.9	120.4	40.6
1955	28.7	11.4	59.3	23.6	251.0	35.0
1956	13.1	6.6	43.5	21.7	200.3	28.3
1957	26.0	9.9	33.1	12.7	261.4	22.6
1958	15.4	8.2	42.7	13.8	188.1	30.9
1959	15.9	8.3	26.3	13.8	190.6	22.1
1960	7.7	6.9	24.0	21.4	112.1	28.3
1961	22.7	12.7	50.1	28.0	179.0	40.7
1962	42.5	25.9	64.7	39.5	163.9	65.4
1963	27.5	13.4	67.3	32.7	205.7	46.1
1964	16.7	11.7	73.0	51.3	142.4	63.0
1965	10.4	6.5	36.2	22.4	161.4	28.9
1966	33.3	19.1	74.0	42.4	174.7	61.4
1967	23.4	13.8	23.7	14.0	169.4	27.8
1968	25.2	16.1	67.5	43.2	156.7	59.2
1969	6.3	3.2	51.1	26.2	195.3	29.4
1970	24.0	18.2	53.2	40.3	132.0	58.5
1971	17.6	9.7	45.1	24.8	181.6	34.5
1972	18.1	18.8	25.1	26.1	96.3	44.9
1973	13.3	8.8	22.4	14.9	150.8	23.7
1974	11.2	12.1	16.9	18.3	92.5	30.4
1975	10.2	6.0	25.5	15.0	169.7	21.0
1976	17.1	11.8	45.0	31.0	145.2	42.8

Source: Yearbook of Fishery Statistics - Catches and Landings, F.A.O. (1958-9773); Historical Catch Statistics for Salmon of the North Pacific Ocean, International North Pacific Fisheries Commission (Unpublished Report); Catch Data from John West Limited, England, 1952-1974.

TABLE XIV-4

TOTAL LANDINGS OF CHUM SALMON IN PACIFIC AREA SHOWING TOTAL AND PERCENTAGE LANDED IN U.S. AND CANADA, 1952 TO 1976

(In Thousands of Metric Tons)

	Canada		U.S.		Total Pacific	Canada & U.S. as % of Total
Year	Metric Tons	%	Metric Tons	%	Metric Tons	%
1952	14.5	13.6	36.6	34.5	106.3	48.1
1953	24.7	23.1	30.1	28.2	106.9	51.3
1954	33.7	20.6	36.6	22.3	163.8	42.9
1955	8.2	5.4	15.6	10.3	152.0	15.7
1956	12.4	7.3	28.1	16.6	169.2	23.9
1957	12.4	10.2	33.1	27.1	122.0	37.3
1958	17.3	12.1	27.7	19.4	142.9	31.5
1959	10.5	8.8	17.5	14.6	119.5	23.4
1960	9.2	7.3	22.6	18.1	125.2	25.4
1961	6.6	6.2	22.2	20.9	106.1	27.1
1962	8.2	7.2	27.1	23.9	113.6	31.1
1963	7.0	6.7	17.1	17.0	104.4	23.7
1964	10.9	9.1	29.9	25.1	119.3	34.2
1965	3.0	3.1	15.0	15.2	98.6	18.3
1966	7.0	5.8	25.6	21.4	119.9	27.2
1967	5.5	6.8	15.6	19.2	81.3	26.0
1968	16.6	17.3	27.6	28.7	96.2	46.0
1969	6.1	9.3	11.1	17.0	65.3	26.3
1970	16.8	16.7	26.0	25.8	100.8	42.5
1971	5.4	5.5	25.9	26.2	98.5	31.7
1972	30.2	23.5	24.7	19.2	128.7	42.7
1973	32.7	26.6	23.9	19.5	122.8	46.1
1974	12.5	10.6	18.5	15.7	117.7	26.3
1975	5.4	4.5	15.3	12.6	121.3	17.1
1976	10.9	9.1	23.9	20.0	119.6	29.1

Source: Yearbook of Fishery Statistics - Catches and Landings, F.A.O. (1958-9773); Historical Catch Statistics for Salmon of the North Pacific Ocean, International North Pacific Fisheries Commission (Unpublished Report); Catch Data from John West Limited, England, 1952-1974.

TABLE XIV-5

TOTAL LANDINGS OF CHINOOK SALMON IN PACIFIC AREA
SHOWING TOTAL AND PERCENTAGE LANDED IN
U.S. AND CANADA, 1952 TO 1976
(In Thousands of Metric Tons)

	Canada		U.S.		Total Pacific	Canada & U.S. as % of Total
Year	Metric Tons	%	Metric Tons	%	Metric Tons	%
1952	6.5	26.3	17.5	70.9	24.7	97.2
1953	7.1	28.5	16.9	67.9	24.9	96.4
1954	6.1	26.4	16.0	69.3	23.1	95.7
1955	5.7	21.9	18.7	71.9	26.0	93.8
1956	6.2	25.1	17.0	68.8	24.7	93.9
1957	5.7	28.6	13.2	66.4	19.9	95.0
1958	6.4	33.0	11.9	61.3	19.4	94.3
1959	6.1	30.3	12.5	62.2	20.1	92.5
1960	4.7	26.3	11.4	63.7	17.9	90.8
1961	4.1	22.7	12.8	70.7	18.1	93.4
1962	4.1	22.9	11.8	65.9	17.9	88.8
1963	4.6	24.2	12.7	65.9	19.0	91.1
1964	6.1	26.5	13.6	59.2	23.0	85.7
1965	5.7	26.0	14.1	64.4	21.9	90.4
1966	7.0	33.5	11.7	56.0	20.9	89.5
1967	7.0	33.4	12.1	57.4	21.0	91.0
1968	6.9	32.7	12.0	56.9	21.1	89.6
1969	6.5	29.3	13.0	58.5	22.2	87.8
1970	6.6	27.2	14.7	60.5	24.3	87.7
1971	8.7	33.6	14.2	54.8	25.9	88.4
1972	8.4	34.6	12.8	52.7	24.3	87.3
1973	7.6	29.7	14.6	57.0	25.6	86.7
1974	7.6	34.2	10.9	49.1	22.2	83.3
1975	7.3	31.3	12.7	54.5	23.3	85.8
1976	7.8	29.7	14.9	56.7	26.3	86.3

Source: Yearbook of Fishery Statistics - Catches and Landings, F.A.O. (1958-9773); Historical Catch Statistics for Salmon of the North Pacific Ocean, International North Pacific Fisheries Commission (Unpublished Report); Catch Data from John West Limited, England, 1952-1974.

APPENDIX XV

ALASKA SALMON CATCH AND VALUE BY REGION
1960 TO 1976

(One table)

TABLE XV-1

SALMON CATCH AND VALUE BY REGION 1960 TO 1976

	Southeast		Central		Western		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1960								
King	5,039,774	1,711,938	835,793	197,682	3,236,699	648,249	9,112,266	2,557,869
Red	3,235,037	830,461	15,339,855	3,628,900	69,589,656	13,633,475	88,164,548	18,092,836
Coho	5,292,095	1,471,224	3,819,813	658,561	439,522	59,641	9,551,430	2,189,426
Pink	10,455,381	1,332,315	39,216,182	5,235,137	2,905,401	247,843	52,576,964	6,815,295
Chum	10,216,266	963,396	24,946,575	2,013,571	12,532,511	923,253	47,695,352	3,900,220
Total	34,238,553	6,309,334	84,158,218	11,733,851	88,703,789	15,512,461	207,100,560	33,555,646
1961								
King	2,970,700	1,255,070	634,500	151,080	4,935,400	836,930	8,540,600	2,243,080
Red	4,754,700	1,238,950	18,131,900	3,994,710	72,342,900	12,305,550	95,229,500	17,539,210
Coho	7,799,600	1,525,800	2,925,500	413,320	660,700	58,280	11,385,800	1,997,400
Pink	63,922,100	6,337,200	39,079,900	3,737,720	535,500	39,880	103,537,500	10,114,800
Chum	23,118,200	2,125,810	16,183,500	1,166,630	6,819,200	553,780	46,120,900	3,846,220
Total	102,565,300	12,482,830	76,955,300	9,463,460	85,293,700	13,794,420	264,814,300	35,740,710
1962								
King	3,765,080	1,753,810	864,500	218,220	4,109,010	726,830	8,738,590	2,698,860
Red	4,858,160	1,319,800	20,143,940	4,645,220	27,944,320	5,165,150	52,946,420	11,130,170
Coho	9,585,580	2,257,150	4,866,300	793,790	779,610	111,020	15,231,490	3,161,960
Pink	45,746,850	5,590,690	88,428,050	13,719,510	9,103,800	986,100	143,278,700	20,296,300
Chum	19,470,180	1,841,190	30,538,940	2,473,820	7,643,440	517,160	57,652,560	4,832,170
Total	83,425,850	12,762,640	144,841,730	21,850,560	49,580,180	7,506,260	277,847,760	42,119,460
1963								
King	4,497,560	2,208,540	693,230	186,270	3,969,740	731,830	9,160,530	3,126,640
Red	3,905,800	1,074,350	13,751,040	3,220,740	17,798,830	3,348,770	35,455,670	7,643,860
Coho	11,304,790	2,109,590	5,444,860	792,800	831,530	106,430	17,581,180	3,008,820
Pink	70,054,650	8,276,680	54,599,550	6,149,450	463,190	46,250	125,117,390	14,472,380
Chum	12,649,630	1,174,960	18,766,000	1,556,590	4,332,780	315,000	35,748,410	3,046,550
Total	102,413,430	14,844,120	93,254,680	11,905,850	37,296,070	4,548,280	223,063,180	31,298,250
1964								
King	6,572,470	2,750,590	467,930	114,880	4,526,600	796,440	11,567,000	3,661,910
Red	5,500,390	1,556,410	18,211,970	4,328,580	30,419,560	6,361,650	54,131,920	12,246,640
Coho	12,834,340	2,376,130	7,451,700	1,124,330	667,880	81,600	20,953,920	3,582,060
Pink	71,505,320	7,735,430	85,513,690	8,882,580	5,261,540	555,950	162,280,550	17,173,960
Chum	19,535,900	1,567,050	34,743,620	2,507,790	8,410,280	619,730	62,689,800	4,694,570
Total	115,948,420	15,985,610	146,388,910	16,958,160	49,285,[illegible]60	[illegible]415,[illegible]70	[illegible],62[illegible],190	[illegible],35[illegible],[illegible]40

TABLE XV-1 (Continued)

	Southeast		Central		Western		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1965								
King	5,428,710	1,942,240	657,760	141,290	4,922,100	966,130	11,008,570	3,049,660
Red	6,620,440	1,796,890	24,035,100	5,492,620	111,378,550	23,512,690	142,034,090	30,802,200
Coho	13,624,730	3,851,900	3,660,310	467,610	380,960	43,870	17,666,000	4,362,380
Pink	42,431,740	4,431,550	32,431,780	3,251,690	9,470	950	74,872,990	7,684,190
Chum	15,033,440	1,436,050	12,443,150	826,400	1,785,960	114,410	29,262,550	2,376,860
Total	83,139,060	13,458,630	73,228,100	10,177,610	118,477,040	24,638,050	274,844,200	48,274,290
1966								
King	4,683,785	2,029,169	555,673	137,253	4,110,637	782,236	9,350,095	2,948,658
Red	7,168,012	2,280,648	27,296,754	6,708,511	58,301,902	10,747,507	92,766,668	19,736,666
Coho	10,800,282	2,915,556	4,399,200	700,297	913,414	89,461	16,112,896	3,705,314
Pink	89,927,949	13,446,435	64,899,174	7,795,942	8,038,915	850,707	162,866,038	22,093,084
Chum	28,149,153	3,535,077	19,493,961	1,820,590	4,586,444	362,565	52,229,558	5,718,232
Total	140,729,181	24,206,885	116,644,762	17,162,593	75,951,312	12,832,476	333,325,255	54,201,954
1967								
King	4,544,905	1,848,758	547,507	139,332	6,539,930	1,112,109	11,632,342	3,100,199
Red	6,120,708	1,819,797	18,781,064	4,715,013	28,619,941	5,329,765	53,521,713	11,864,575
Coho	7,796,034	2,552,695	4,009,634	649,072	1,216,570	141,008	13,022,238	3,342,775
Pink	14,000,630	1,677,899	14,684,873	1,552,403	136,553	10,559	28,822,056	3,240,861
Chum	17,379,956	1,868,108	9,616,197	832,430	4,522,132	382,287	31,518,285	3,082,825
Total	49,842,233	9,767,257	47,639,275	7,888,250	41,035,126	6,975,728	138,516,634	24,631,235
1968								
King	5,372,147	2,310,023	466,294	149,214	5,407,285	1,405,894	11,245,726	3,865,131
Red	5,815,425	1,744,628	25,827,977	6,715,274	17,052,425	4,263,107	48,695,827	12,723,009
Coho	12,190,448	3,413,326	6,515,174	1,563,642	2,262,799	384,676	20,968,421	5,361,644
Pink	82,781,816	12,417,273	56,003,647	6,720,438	9,660,433	1,352,461	148,445,896	20,490,172
Chum	28,822,422	4,035,138	23,014,365	2,531,581	4,079,412	448,736	55,916,199	7,015,456
Total	134,982,258	23,920,389	111,827,457	17,680,149	38,462,354	7,854,874	285,272,069	49,455,412
1969								
King	4,236,462	2,007,339	705,719	236,220	5,804,308	1,262,288	10,746,489	3,505,847
Red	4,707,164	1,639,005	23,359,635	5,933,708	43,668,046	10,473,753	71,734,845	18,046,466
Coho	4,354,377	1,580,710	1,942,929	388,794	1,736,262	259,989	8,033,568	2,229,493
Pink	20,453,437	3,439,043	84,317,037	12,160,687	1,196,564	111,863	105,967,038	15,711,593
Chum	5,165,036	954,284	12,496,269	1,454,561	5,007,158	525,612	22,668,463	2,934,457
Total	38,916,476	9,620,381	122,821,589	20,173,970	57,412,338	12,633,505	219,150,403	42,427,856

TABLE XV-1 (Continued)

	Southeast		Central		Western		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1970								
King	4,588,764	3,608,297	911,865	299,264	6,045,994	1,127,230	11,546,623	5,034,791
Red	4,248,930	1,334,071	37,449,784	9,756,152	109,113,466	26,159,254	150,812,180	37,249,477
Coho	5,822,974	2,065,255	5,182,728	1,319,355	892,255	127,198	11,897,957	3,511,808
Pink	41,442,236	5,428,100	71,852,748	9,633,457	4,422,700	500,955	117,717,684	15,562,512
Chum	20,483,428	2,848,068	24,700,988	2,765,357	9,306,107	1,002,721	54,490,523	6,616,146
Total	76,586,332	15,283,791	140,098,113	23,773,585	129,780,522	28,917,358	346,464,967	67,974,734
1971								
King	4,528,834	2,976,194	1,062,772	389,560	6,380,288	1,322,568	11,971,894	4,688,322
Red	3,967,147	1,418,826	23,795,979	6,053,327	59,524,528	15,376,574	87,287,654	22,848,727
Coho	7,136,576	1,928,614	4,013,394	845,094	309,447	46,435	11,459,417	2,820,143
Pink	34,414,077	5,231,120	51,702,552	8,270,327	143,138	16,407	86,259,767	13,517,854
Chum	16,095,008	2,536,503	29,282,200	3,906,834	9,349,112	1,093,045	54,726,320	7,536,382
Total	66,141,642	14,091,257	109,856,897	19,465,142	75,706,513	17,855,029	251,705,052	51,411,428
1972								
King	3,376,087	2,196,959	1,198,320	502,645	5,398,491	1,031,772	9,972,898	3,731,376
Red	5,698,331	2,255,689	20,505,410	6,679,065	15,779,781	4,245,480	41,983,522	13,180,234
Coho	10,585,584	5,028,553	1,983,346	470,440	465,822	83,883	13,034,752	5,582,876
Pink	38,468,017	6,950,194	20,909,084	3,866,452	591,805	65,329	59,968,906	10,881,975
Chum	26,840,276	6,143,224	28,735,422	4,825,552	9,247,773	949,754	64,823,471	11,918,530
Total	84,968,295	22,574,619	73,331,582	16,344,154	31,483,672	6,376,218	189,783,549	45,294,991
1973								
King	4,748,833	5,199,408	945,000	1,718,007	3,223,098	962,892	8,916,931	7,880,307
Red	7,023,806	4,645,909	19,065,552	7,485,600	9,158,786	3,195,222	35,248,144	15,326,731
Coho	6,161,160	5,345,304	2,755,798	1,779,053	919,888	345,200	9,836,845	7,469,557
Pink	23,423,770	6,414,841	12,991,245	5,233,438	195,146	18,199	36,610,161	11,666,478
Chum	17,748,456	9,222,658	18,058,686	6,459,163	10,073,706	2,033,945	45,880,848	17,715,766
Total	59,106,025	30,828,120	53,816,281	22,675,261	23,570,624	6,555,458	136,492,930	60,058,839
1974								
King	4,744,750	4,709,611	920,794	672,617	3,624,486	1,562,739	9,290,030	6,944,968
Red	4,657,449	3,260,384	17,326,243	13,817,024	10,262,765	5,050,591	32,246,457	22,128,999
Coho	9,412,587	6,920,061	2,294,904	1,385,398	1,112,690	375,481	12,820,181	8,680,942
Pink	19,270,771	6,670,565	16,331,676	6,172,219	4,469,575	1,158,176	40,072,022	14,000,961
Chum	17,005,676	7,115,138	6,731,854	2,954,559	13,436,720	3,907,211	37,174,250	13,976,909
Total	55,091,233	28,676,762	43,605,471	25,001,820	32,906,236	12,054,199	131,602,940	65,732,782

TABLE XV-1 (Continued)

	Southeast		Central		Western		Total	
1975	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
King	3,973,713	3,879,668	720,571	465,281	2,247,727	913,280	6,942,011	5,258,230
Red	1,522,036	910,786	13,078,516	6,963,484	28,161,568	11,355,670	42,762,120	19,229,940
Coho	3,083,857	2,243,105	3,059,609	1,665,237	984,835	337,977	7,128,301	4,246,319
Pink	15,552,250	4,912,539	34,315,659	11,111,019	101,091	29,824	49,969,000	16,053,384
Chum	6,430,914	3,261,962	9,213,841	3,445,180	15,160,626	3,806,890	30,805,381	10,514,033
Total	30,562,770	15,208,062	60,388,196	23,650,203	46,655,847	16,443,642	137,606,813	55,301,908
1976								
King	3,098,932	NA	1,308,418	NA	4,193,645	NA	8,600,995	NA
Red	3,930,665	NA	33,748,146	NA	45,005,951	NA	82,684,762	NA
Coho	6,354,875	NA	3,507,197	NA	782,148	NA	10,644,220	NA
Pink	23,350,853	NA	75,084,443	NA	3,965,931	NA	102,401,227	NA
Chum	11,009,767	NA	18,437,937	NA	10,195,802	NA	39,643,506	NA
Total	47,745,092	NA	132,086,141	NA	64,143,477	NA	243,974,710	NA

APPENDIX XVI

ALASKA SALMON CATCH BY MANAGEMENT DISTRICT 1960 TO 1977

TABLE XVI-1

SALMON CATCH BY DISTRICT 1960 TO 1975
(In Pounds)

Year	District	King	Red	Coho	Pink	Chum	All Species
1960	Southeast	5,024,909	2,969,279	4,401,441	10,406,606	10,090,770	32,893,005
	Yakutat	14,892	265,717	890,731	48,923	125,210	1,345,473
	P. W. Sound	208,305	2,381,107	1,481,448	6,058,475	2,649,858	12,779,193
	Cook Inlet	555,374	5,069,989	1,936,561	6,253,626	5,197,333	19,012,883
	Kodiak	24,969	1,961,985	335,732	21,459,947	8,810,115	32,592,748
	Chignik & S. AK Penn.	47,155	5,927,688	65,801	5,443,684	8,290,459	19,774,787
	Aleutians & N. AK Penn.	254,760	3,382,405	294,545	1,782,755	3,958,288	9,672,753
	Bristol Bay	2,725,553	66,181,455	108,138	1,122,653	8,574,776	78,712,575
	AYK	1,795,401	27,279	36,837	--	20	1,859,537
1961	Southeast	2,937,659	4,224,690	6,656,592	63,591,402	23,013,817	100,424,160
	Yakutat	32,792	529,585	1,142,723	329,089	104,060	2,138,249
	P. W. Sound	182,693	4,005,104	1,605,430	10,333,332	1,759,111	17,885,670
	Cook Inlet	405,902	7,015,522	974,932	1,463,226	3,138,921	12,998,503
	Kodiak	17,734	2,440,938	233,919	17,561,101	4,036,276	24,289,968
	Chignik & S. AK Penn.	28,140	4,668,427	110,849	9,720,160	7,247,268	21,774,844
	Aleutians & N. AK Penn.	122,809	2,294,395	242,580	393,459	1,056,087	4,109,330
	Bristol Bay	1,799,628	70,030,057	203,503	2,184	5,008,172	77,043,544
	AYK	3,012,899	13,566	214,540	139,843	754,440	4,135,288
1962	Southeast	3,697,889	4,218,565	8,088,688	45,074,188	18,795,456	79,874,786
	Yakutat	50,104	492,075	1,483,871	107,999	170,183	2,304,232
	P. W. Sound	377,843	4,876,584	2,110,303	20,643,597	6,518,506	34,526,833
	Cook Inlet	435,805	6,287,863	2,258,957	15,433,686	9,194,320	33,610,631
	Kodiak	8,760	4,001,786	360,248	42,341,553	6,357,816	53,070,163
	Chignik & S. AK Penn.	29,557	5,716,789	118,054	9,394,337	8,550,216	23,808,953
	Aleutians & N. AK Penn.	73,320	1,465,139	275,138	6,088,908	273,165	8,175,670
	Bristol Bay	1,319,538	26,420,890	247,489	2,924,589	4,607,306	35,519,812
	AYK	2,716,156	58,290	256,985	90,305	2,762,966	5,884,702

TABLE XVI-1 (Continued)

Year	District	King	Red	Coho	Pink	Chum	All Species
1963	Southeast	4,403,934	3,438,655	9,142,025	59,104,969	12,918,972	89,008,555
	Yakutat	16,108	289,911	1,181,490	245,458	93,975	1,826,942
	P. W. Sound	338,105	2,848,671	3,181,949	23,837,405	8,783,636	38,989,766
	Cook Inlet	347,350	5,168,329	1,431,523	794,838	3,773,124	11,515,164
	Kodiak	2,031	2,198,016	410,479	18,084,521	2,196,439	22,891,486
	Chignik & S. AK Penn.	12,025	3,800,557	200,997	14,275,613	4,152,650	22,441,842
	Aleutians & N. AK Penn.	34,248	1,194,482	291,607	340,477	357,632	2,218,446
	Bristol Bay	821,951	14,930,146	284,708	1,521	2,331,611	18,369,937
	AYK	3,001,454	248	240,529	128,871	1,276,334	4,647,436
1964	Southeast	6,535,422	4,990,128	11,486,642	70,456,066	19,497,868	112,966,126
	Yakutat	36,892	553,410	1,375,429	153,490	57,257	2,176,478
	P. W. Sound	338,165	4,446,257	4,298,780	16,502,912	4,744,353	30,330,467
	Cook Inlet	96,138	5,349,537	2,911,217	14,921,571	11,780,135	35,058,598
	Kodiak	10,187	2,492,440	287,834	39,746,325	9,526,969	52,063,755
	Chignik & S. AK Penn.	20,917	6,406,988	94,692	14,097,283	9,545,404	30,165,284
	Aleutians & N. AK Penn.	29,822	1,268,395	277,947	622,973	1,088,380	3,287,517
	Bristol Bay	1,911,794	29,073,314	219,378	4,594,707	5,734,010	41,533,203
	AYK	2,594,447	77,848	170,208	34,099	1,589,670	4,466,272
1965	Southeast	5,401,000	5,871,000	12,521,000	42,415,000	14,990,000	81,198,000
	Yakutat	28,000	749,000	1,104,000	17,000	43,000	1,941,000
	P. W. Sound	392,000	5,208,000	1,580,000	8,123,000	1,510,000	16,813,000
	Cook Inlet	218,000	8,831,000	1,560,000	502,000	2,997,000	14,108,000
	Kodiak	6,000	1,835,000	214,000	10,970,000	3,537,000	16,562,000
	Chignik & S. AK Penn.	42,000	8,161,000	306,000	12,837,000	4,399,000	25,745,000
	Aleutians & N. AK Penn.	93,000	977,000	248,000	7,000	453,000	1,778,000
	Bristol Bay	1,649,000	110,338,000	51,000	1,000	676,000	112,715,000
	AYK	3,180,000	64,000	82,000	1,000	657,000	3,984,000
1966	Southeast	4,651,075	5,907,557	10,207,039	89,921,811	28,119,956	138,807,438
	Yakutat	32,710	1,260,455	593,243	6,138	29,197	1,921,743
	P. W. Sound	311,176	7,577,583	1,766,574	10,765,038	3,703,960	24,124,331
	Cook Inlet	221,829	11,012,486	1,887,891	8,804,426	4,922,693	26,849,325
	Kodiak	8,625	3,537,218	568,680	41,946,770	5,873,298	51,934,591
	Chignik & S. AK Penn.	14,043	5,169,467	176,055	3,382,940	4,994,010	13,736,515
	Aleutians & N. AK Penn.	65,401	1,478,040	346,890	278,102	526,588	2,695,021
	Bristol Bay	1,510,704	56,816,358	254,564	7,727,838	2,574,608	68,884,072
	AYK	2,534,532	7,504	311,960	32,975	1,485,248	4,372,219

TABLE XVI-1 (Continued)

Year	District	King	Red	Coho	Pink	Chum	All Species
1967	Southeast	4,511,836	5,563,593	6,713,460	13,854,236	17,337,034	47,980,159
	Yakutat	33,069	557,115	1,082,574	146,394	42,922	1,862,074
	P. W. Sound	303,844	3,647,910	2,529,743	11,702,079	2,281,847	20,465,423
	Cook Inlet	175,967	8,439,624	1,297,807	1,577,741	3,081,920	14,573,059
	Kodiak	30,152	1,852,536	83,867	788,815	1,858,784	4,614,154
	Chignik & S. AK Penn.	37,544	4,840,994	98,217	616,238	2,393,646	7,986,639
	Aleutians & N. AK Penn.	96,669	1,326,951	402,841	28,401	305,339	2,160,201
	Bristol Bay	2,461,053	27,283,599	376,572	3,453	3,239,228	33,363,905
	AYK	3,982,208	9,391	437,157	104,699	977,565	5,511,020
1968	Southeast	5,310,571	5,249,965	11,222,722	82,774,170	28,670,956	133,228,384
	Yakutat	61,576	565,460	967,726	7,646	151,466	1,753,874
	P. W. Sound	284,204	5,181,923	2,973,593	9,278,562	2,640,711	20,358,993
	Cook Inlet	120,468	7,082,006	2,803,934	8,156,508	9,847,137	28,010,053
	Kodiak	29,427	4,410,279	464,358	29,811,615	6,078,467	40,794,146
	Chignik & S. AK Penn.	32,195	9,153,769	273,289	8,756,962	4,448,050	22,664,265
	Aleutians & N. AK Penn.	74,452	1,368,929	448,679	2,951,269	535,039	5,378,368
	Bristol Bay	1,835,897	15,639,954	522,894	6,194,675	2,291,883	26,485,303
	AYK	3,496,936	43,542	1,291,226	514,489	1,252,490	6,598,683
1969	Southeast	4,172,116	4,023,941	3,919,129	20,184,242	5,027,634	37,327,062
	Yakutat	64,346	683,223	435,248	269,195	137,402	1,589,414
	P. W. Sound	397,218	7,167,463	671,603	19,221,123	2,730,464	30,187,871
	Cook Inlet	226,878	4,830,617	709,990	931,667	2,426,582	9,125,734
	Kodiak	30,368	3,371,442	370,568	51,868,285	4,172,477	59,813,140
	Chignik & S. AK Penn.	51,255	7,990,113	190,768	12,295,962	3,166,746	23,694,844
	Aleutians & N. AK Penn.	97,930	2,072,586	334,064	872,139	204,537	3,581,256
	Bristol Bay	2,516,980	41,519,817	501,980	6,732	2,282,214	46,827,723
	AYK	3,189,398	75,643	900,218	317,693	2,520,407	7,003,359
1970	Southeast	4,460,369	3,570,345	5,472,535	41,425,311	20,416,271	75,344,831
	Yakutat	128,395	678,585	350,439	16,925	67,157	1,241,501
	P. W. Sound	606,600	7,561,167	2,401,031	11,516,681	1,972,884	24,058,363
	Cook Inlet	224,557	4,334,130	1,898,098	4,971,544	7,023,178	18,451,507
	Kodiak	16,690	5,484,019	528,908	43,834,219	6,552,567	56,416,403
	Chignik & S. AK Penn.	64,018	20,070,468	354,691	11,530,304	9,152,359	41,171,840
	Aleutians & N. AK Penn.	93,748	1,298,465	203,811	2,715,580	319,656	4,631,260
	Bristol Bay	2,936,678	107,747,983	104,328	1,416,424	4,235,291	116,440,704
	AYK	3,015,568	67,018	584,116	290,696	4,751,160	8,708,558

TABLE XVI-1 (Continued)

Year	District	King	Red	Coho	Pink	Chum	All Species
1971	Southeast	4,391,192	3,130,528	6,777,162	34,132,335	16,053,940	64,485,157
	Yakutat	137,642	836,619	359,414	281,742	41,068	1,656,485
	P. W. Sound	484,583	4,927,700	3,010,198	26,619,298	4,159,738	39,201,517
	Cook Inlet	512,665	3,666,433	638,712	1,043,682	2,682,752	8,544,244
	Kodiak	11,636	3,071,143	155,440	16,744,774	11,158,023	31,141,016
	Chignik & S. AK Penn.	53,888	12,130,703	209,044	7,294,798	11,281,687	30,970,120
	Aleutians & N. AK Penn.	43,627	1,879,387	57,505	126,903	398,412	2,505,834
	Bristol Bay	2,629,459	57,606,631	83,702	824	4,332,199	64,652,815
	AYK	3,707,202	38,510	168,240	15,411	4,618,501	8,547,864
1972	Southeast	3,286,551	4,866,238	10,100,113	38,456,384	26,765,845	83,475,131
	Yakutat	89,536	832,093	485,471	11,633	74,431	1,493,164
	P. W. Sound	683,396	6,371,233	1,058,938	326,253	432,592	8,872,412
	Cook Inlet	464,605	5,471,203	508,950	2,526,126	4,722,498	13,693,382
	Kodiak	29,574	2,355,991	220,826	17,480,891	17,654,783	37,742,065
	Chignik & S. AK Penn.	20,745	6,306,983	194,632	575,814	5,925,549	13,023,723
	Aleutians & N. AK Penn.	17,024	1,107,657	74,265	10,741	615,624	1,825,311
	Bristol Bay	1,609,305	14,642,371	93,512	425,526	4,373,016	21,143,730
	AYK	3,772,162	29,753	298,045	155,538	4,259,133	8,514,631
1973	Southeast	4,673,949	6,145,602	5,784,189	23,351,310	17,659,073	57,614,123
	Yakutat	74,884	878,204	376,971	72,460	89,383	1,491,902
	P. W. Sound	707,264	3,453,094	1,868,591	8,334,670	7,399,514	21,763,133
	Cook Inlet	201,681	5,119,989	648,113	2,266,347	5,758,153	13,994,283
	Kodiak	10,653	1,091,853	24,304	2,068,089	2,709,526	5,904,425
	Chignik & S. AK Penn.	25,402	9,400,616	214,790	322,139	2,191,493	12,154,440
	Aleutians & N. AK Penn.	42,167	940,980	76,023	10,020	1,147,406	2,232,569
	Bristol Bay	1,009,483	8,186,374	374,678	1,607	2,104,874	11,676,416
	AYK	2,171,448	31,432	469,187	183,519	6,821,426	9,677,012
1974	Southeast	4,632,481	4,087,705	8,684,264	19,249,876	16,963,559	53,617,885
	Yakutat	112,269	569,744	728,323	20,895	42,117	1,473,348
	P. W. Sound	656,347	5,139,957	699,504	2,172,267	841,026	9,509,051
	Cook Inlet	245,154	3,544,257	1,320,191	2,201,264	2,988,595	10,299,461
	Kodiak	7,588	2,611,570	114,703	11,268,189	2,118,618	16,120,668
	Chignik & S. AK Penn.	11,705	6,030,459	160,556	689,956	783,615	7,676,291
	Aleutians & N. AK Penn.	107,282	1,406,897	186,647	37,353	261,614	1,999,793
	Bristol Bay	1,030,136	8,711,387	326,480	3,717,294	754,871	14,540,168
	AYK	2,487,068	144,481	599,563	714,928	12,420,235	16,366,275

TABLE XVI-1 (Continued)

Year	District	King	Red	Coho	Pink	Chum	All Species
1975	Southeast	3,884,842	1,062,970	2,723,697	15,255,210	6,398,776	29,325,495
	Yakutat	88,871	459,066	360,160	297,040	32,138	1,237,275
	P. W. Sound	579,361	3,827,155	779,989	16,381,440	759,989	22,327,934
	Cook Inlet	123,295	4,341,285	1,607,464	4,969,131	6,853,415	17,894,590
	Kodiak	1,671	826,713	203,907	12,470,661	641,305	14,144,257
	Chignik & S. AK Penn.	16,244	4,083,363	468,249	494,427	959,132	6,021,415
	Aleutians & N. AK Penn.	32,906	1,365,187	236,694	2,637	67,842	1,705,266
	Bristol Bay	535,772	26,706,170	362,908	1,806	2,022,806	29,629,462
	AYK	1,679,049	90,211	385,233	96,648	13,069,978	15,321,119

Source: Alaska Department of Fish & Game, Statistical Leaflets, 1960 to 1975.

TABLE XVI-2

PRELIMINARY 1976 AND 1977 CATCH STATISTICS BY SPECIES AND ALASKA DEPARTMENT OF FISH AND GAME MANAGEMENT AREA

	Kings	Reds	Cohos	Pinks	Chums	Total
1976						
Juneau	572,722	2,243,329	2,595,576	265,986	5,756,276	11,433,889
Ketchikan	1,029,403	1,488,746	1,418,539	19,148,385	4,980,243	28,065,316
Petersburg/ Wrangell	392,436	107,619	749,571	3,493,127	243,706	4,986,459
Sitka	1,104,371	90,971	1,591,189	443,355	29,542	3,259,428
P.W.S.	921,395	6,996,494	1,639,340	12,769,175	3,374,956	25,701,360
Cook Inlet	305,246	11,773,039	1,365,441	5,625,673	4,228,332	23,297,731
Kodiak	13,700	4,056,252	205,030	44,639,533	6,340,352	55,254,868
Chignik	29,229	8,562,989	294,954	1,749,923	678,545	11,315,640
N/S Peninsula	117,520	5,920,007	206,709	10,302,723	4,362,946	20,909,905
Briston Bay	1,647,431	41,354,981	181,125	3,555,490	1,709,714	48,447,741
Kuskokwim	583,037	88,975	312,043	135,448	673,264	1,791,749
Kotzebue	76			411	1,415,549	1,416,036
Yukon	1,851,309	160	34,881	131	5,181,375	7,067,856
Norton Sound/ Port Clar	34,120	1,200	49,822	271,867	669,723	1,206,732
Total	8,600,995	82,684,762	10,644,220	102,401,227	39,643,506	243,974,710
1977						
Juneau	759,997	3,112,664	4,036,922	1,756,291	2,683,593	12,549,467
Ketchikan	735,776	3,440,827	2,060,059	40,362,045	3,779,140	50,377,847
Petersburg/ Wrangell	276,337	906,722	797,884	14,707,597	572,052	17,260,592
Sitka	2,426,534	94,993	1,351,793	11,038,866	274,609	15,186,795
P.W.S.	641,790	7,138,506	1,916,867	20,538,098	5,197,265	35,423,526
Cook Inlet	422,232	16,209,665	1,315,340	6,897,710	11,169,229	36,014,176
Kodiak	12,343	4,240,370	242,287	25,844,663	9,776,701	40,114,364
Chignik	21,176	17,247,589	156,393	2,435,862	927,595	20,788,615
N/S Peninsula	122,272	5,200,098	321,730	5,756,016	2,904,651	14,304,827
Bristol Bay	2,982,093	40,377,468	834,769	27,870	3,186,009	47,408,209
Kuskokwim	1,337,678	138,395	2,004,444	1,446	2,016,509	5,498,472
Kotzebue	269			54	1,847,092	1,847,472
Yukon	2,230,203		295,549		5,630,139	8,155,891
Norton Sound/ Port Clar	102,341	39	28,254	162,457	1,415,981	1,709,072
Total	12,071,041	98,107,336	15,362,291	129,529,035	51,578,565	306,648,268

Source: Alaska Department of Fish and Game Computer Printout, run R41-115-2020.

APPENDIX XVII

1978 HARVEST AND PROCESSING CAPACITY MEASUREMENTS BY ALASKA DEPARTMENT OF FISH AND GAME (ADF&G)

TABLE XVII-1

THE 1978 ANTICIPATED PEAK DAILY HARVEST RATES AND TOTAL PROJECTED HARVEST, ALL SPECIES COMBINED FOR MAJOR ALASKAN FISHERIES

Area	Anticipated Peak Daily Harvest Rate (All species combined)	Projected Total Harvest (All Species Combined)		
		Point Estimate	Range Top End	Actual Harvest Sept. 24, 1978
Southeastern	1.3	20.3	26.6	21.587
Cook Inlet	0.2	3.3	4.0	.542
Kodiak	0.9	12.8	15.1	16.200
Chignik	0.2	3.0	4.4	2.608
Alaska Peninsula	0.3	3.6	4.8	8.185
Bristol Bay	1.5	3.7	17.6	15.982
Total	4.1	51.8	72.5	65.734

Source: Alaska Department of Fish and Game, Division of Commercial Fisheries, Evaluation of Alaskan Salmon Processing Capacity for the 1978 Season.

TABLE XVII-2

PRELIMINARY FORECAST AND ESTIMATES OF SALMON RETURNED TO SOME MAJOR ALASKAN FISHERIES IN 1978
(In Thousands of Fish)

Area	Species	Forecast Run Range	Estimated Harvest Range	Point Estimate of Harvest	Actual Harvest
Southern Southeastern	Pink	17,200-27,000	11,200-21,000	16,100	
Northern Southeastern	Pink	3,000- 7,000	800- 3,600	2,200	
Total	Pink	20,200-34,000	12,000-24.600	18,300	18,792
Prince William Sound (Natural)	Pink	2,700- 5,700	1,900- 4,900	3,000	
Prince William Sound (Supplemental)	Pink	143- 303	118- 270	198	
Total	Pink	2,843- 6,003	1,618- 4,778	3,198	2,768
Cook Inlet (Natural)	Pink	180- 1,100	64- 886	408	
Cook Inlet (Supplemental)	Pink	34- 210	24- 200	90	
Total	Pink	214- 1,310	8- 1,024	499	324
Kodiak	Pink	11,800-16,400	9,100-13,700	11,400	14,162
Chignik	Pink	1,800- 3,700	1,000- 2,900	1,975	946
	Sockeye	1,300- 2,150	660- 1,600	1,075	1,535
South Peninsula	Pink	3,300- 5,500	2,200- 4,400	3,200	5,913
Bristol Bay/ Nushagak Dist.	Pink	2,000- 4,000	1,200- 3,200	2,400	
Bristol Bay	Sockeye	7,000-16,000	1,500-10,500	6,800	9,791

Source: Alaska Department of Fish and Game, Division of Commercial Fisheries.

TABLE XVII-3

SUMMARY OF ESTIMATED PROCESSING CAPACITIES FOR MAJOR STATISTICAL AREAS IN ALASKA
(In Millions of Salmon)

Area	Canning		Frozen		Combined		Catch as
	Daily	Seasonal	Daily	Seasonal	Daily	Seasonal	of November 13, 1978
Southeastern	0.7	17.8	0.15	3.5	0.9[3]	21.8	21.719
Prince William Sound[4]	.439		267.5 tons				3.491
Cook Inlet	0.2	6.6	0.3	1.3	0.5	7.9	5.667
Kodiak	0.8	15.7	0.08	2.4	0.9	18.1	16.942
Chignik	0.1	2.2	0.01	0.3	0.1[2]	2.5	2.702
Alaska Peninsula	0.2	4.2	0.05	1.4	0.2	5.6	8.586
Bristol Bay							
East side	0.8	9.4	0.4	4.2	1.7[1]	13.6	
West side	0.3	5.2	0.05	0.2	0.7[1]	5.4	
Total Bristol Bay	1.1	14.6	.5	4.4	2.9[1]	19.0	16.313

Sources: Alaska Department of Fish and Game, Division of Commercial Fisheries, OCS Socioeconomic Study of Alaska Coastal Communities.

[1]Short term capacity (3 days).
[2]Capacity estimate excludes 400,000 fish tender capacity projected for the Chignik sockeye salmon fishery .
[3]Capacity estimate excludes 350,000 fish tender capacity potentially available to transport fish to Canada or Washington.
[4]The processing capacities here represent peak daily operating capacity with all labor devoted to the processing of salmon.

TABLE XVII-4

SUMMARY OF PLANTS AND OPERATIONAL CANNING LINES AVAILABLE, 1978 SALMON SEASON BY AREA

Area	Plants	1/4 lb.	1/2 lb.	1 lb.	4 lb.	Total
Southeastern	11	1	4	14	4	23
Cook Inlet	6	3	8	8	0	19
Kodiak	8	0	6	8	1	15
Chignik	1	0	1	2	0	3
Alaska Peninsula	2	2	3	3	-	8
Bristol Bay						
East side	9	0	10	16	0	26
West side	4	1	6	7	0	14
Total Bay	13	1	16	23	0	40
Total	41	7	38	53	5	108

Source: Alaska Department of Fish and Game, Division of Commercial Fisheries, Evaluation of Alaskan Salmon Processing Capacity for 1978.

APPENDIX XVIII

WORLD TRADE STATISTICS OF THE SALMON INDUSTRY

APPENDIX XVIII

WORLD TRADE STATISTICS OF THE SALMON INDUSTRY

The following tables describe the world trade situation of salmon up to 1977. Table XVIII-1 describes the world trade of canned and frozen salmon by product weight with the percentages going to each major process. The interesting feature of this information is that the growing role of frozen salmon in world trade is increasingly apparent.

Table XVIII-2 describes the United States imports of fresh/frozen and canned salmon from 1960 to 1977.

Table XVIII-3 through 10 describe the yearly import activity of each major consumer of salmon individually, describing not only the amount of import but also the country of origin. It is noted that Japan has consistently been the leading exporter of canned salmon products up to 1976. It is strongly suspected that subsequent yearly additions to this data set will show that 1977 and 1978 were years of change for Japan, and that they became less of an exporting nation of canned salmon goods and more of an importing nation due to the Japanese collapse of the salmon canning industry.

Table XVIII-11 shows that for frozen salmon, the United States is the leading exporter in the world. This position, however, is shared closely with Canada, another leading producer.

TABLE XVIII-1

WORLD TRADE OF CANNED AND FROZEN SALMON
BY PRODUCT WEIGHT, 1961 TO 1976
(In Thousands of Metric Tons)

YEAR	CANNED	% of TOTAL	FROZEN	% of TOTAL	TOTAL	%
1961	42.1	-	NA	-	NA	-
1962	74.2	-	NA	-	NA	-
1963	53.8	-	NA	-	NA	-
1964	58.8	-	NA	-	NA	-
1965	64.6	84.1	12.2	15.9	76.8	100.0
1966	47.4	73.3	17.3	26.7	64.7	100.0
1967	59.3	77.5	17.2	22.5	76.5	100.0
1968	63.4	78.8	17.1	21.2	80.5	100.0
1969	48.9	56.3	26.0	34.7	74.9	100.0
1970	43.3	64.6	23.7	35.4	67.0	100.0
1971	52.3	68.5	24.1	31.5	76.4	100.0
1972	57.8	65.1	31.0	34.9	88.8	100.0
1973	43.2	48.1	46.6	51.9	89.8	100.0
1974	33.3	56.1	26.1	43.9	59.4	100.0
1975	39.5	52.2	36.2	47.8	75.7	100.0
1976	40.2	55.6	32.1	44.4	72.3	100.0

Source: Yearbook of Fishery Statistics - Fishery Commodities, Rome, Italy, F.A.O., 1961-76 (Annual)

TABLE XVIII-2

U.S. SALMON IMPORTS, 1960 TO 1977
(In Thousands of Pounds)

YEAR	FRESH/FROZEN	CANNED
1960	13,472	19,113
1961	12,309	7,167
1962	9,735	6,843
1963	8,898	1,250
1964	8,818	236
1965	7,861	101
1966	8,296	589
1967	8,815	121
1968	9,811	4,955
1969	8,425	2,217
1970	7,448	2,441
1971	7,684	1,551
1972	18,696	11,647
1973	18,237	7,859
1974	12,483	8,553
1975	9,250	3,265
1976	7,742	2,521
1977	5,708	586

Source: U. S. Department of Commerce, N.M.F.S., Fisheries of the United States, 1960-1977.

TABLE XVIII-3

IMPORTS OF CANNED SALMON BY AUSTRALIA:
COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

YEAR	JAPAN	CANADA	U.S.	USSR	TOTAL[1]
1961	3.9	.3	--	.4	4.6
1962	3.2	.5	--	--	3.7
1963	3.1	1.1	.1	.1	4.4
1964	4.1	1.2	.3	.2	5.5
1965	4.4	.6	.3	.3	5.6
1966	4.3	.7	.2	.2	5.4
1967	3.1	1.0	.2	.4	4.7
1968	3.6	.4	.1	.1	4.2
1969	4.3	.3	.2	.1	4.9
1970	2.5	.1	.2	.1	2.9
1971	4.7	.1	.3	--	5.1
1972	5.2	.2	.3	--	3.7
1973	3.2	.1	.4	--	3.7
1974	2.4	1.2	.5	--	4.1
1975	2.3	.1	.1	--	2.5
1976	4.2	.5	1.0	--	5.7

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

[1]Total - in some years exports to Australia will be shown in F.A.O. statistics as exports to the category "Other Countries" and this total will not include such exports. Exports from Canada to Australia (Table) are based on Canadian export information.

This could also be true for other countries importing small quantities.

TABLE XVIII-4

IMPORTS OF CANNED SALMON BY FRANCE:
COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

YEAR	CANADA 000 Tons	JAPAN 000 Tons	USSR 000 Tons	Total
1961	.2	.8	---	1.0
1962	.4	.5	---	.9
1963	.9	1.4	---	2.3
1964	.7	.9	---	1.6
1965	.2	1.3	---	1.5
1966	.5	.9	---	1.4
1967	.7	.5	---	1.2
1968	.3	1.4	---	1.7
1969	.2	1.0	---	1.2
1970	.1	.9	---	1.0
1971	.1	1.3	.6	2.0
1972	.3	1.7	.8	2.8
1973	*	.3	1.2	1.5
1974	.3	.3	.1	.7
1975	.3	.5	.1	.9
1976	---	.2	1.3	1.5

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

*Included under other

TABLE XVIII-5

IMPORTS OF CANNED SALMON BY ITALY:
COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

YEAR	CANADA 000 Tons	JAPAN 000 Tons	TOTAL
1961	.2	.2	.4
1962	.3	.1	.4
1963	.8	.1	.9
1964	.5	.1	.6
1965	.3	--	.3
1966	.4	.2	.6
1967	.7	--	.7
1968	.4	--	.4
1969	.3	--	.3
1970	.5	--	.5
1971	.4	--	.4
1972	.3	--	.3
1973	.3	--	.3
1974	.2	--	.2
1975	--	--	--
1976	--	--	--

Source : Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

Imports from other countries too small to be recorded.

TABLE XVIII-6

IMPORTS OF CANNED SALMON BY THE NETHERLANDS:
COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

	CANADA		JAPAN		U.S.A.		
YEAR	000 Tons	%	000 Tons	%	000 Tons	%	TOTAL
1961	.2	8.3	1.9	79.2	.3	12.5	2.4
1962	.3	17.6	1.2	70.6	.2	11.8	1.7
1963	.4	17.4	1.7	73.9	.2	8.7	2.3
1964	.9	29.0	1.2	38.7	1.0	32.2	3.1
1965	.3	8.6	1.9	54.3	1.3	37.2	3.5
1966	.5	26.2	1.0	47.6	.6	28.6	2.1
1967	.7	25.9	1.3	48.1	.7	25.9	2.7
1968	.5	20.8	1.4	58.3	.5	20.8	2.4
1969	.2	8.3	1.4	58.3	.8	33.3	2.4
1970	*	--	1.8	69.2	.8	30.8	2.6
1971	*	--	1.9	67.9	.9	32.1	2.8
1972	*	--	2.4	80.0	.6	20.0	3.0
1973	*	--	1.0	66.7	.5	33.3	1.5
1974	--	--	1.2	85.7	.2	14.3	1.4
1975	.2	7.1	1.8	64.3	.8	28.6	2.8
1976	.1	2.9	2.3	65.7	1.1	31.4	3.5

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

*Small quantities only

TABLE XVIII-7

IMPORTS OF CANNED SALMON BY BELGIUM AND LUXEMBOURG: COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

	CANADA		JAPAN		U.S.A.		USSR		
YEAR	000 Tons	%	000 Tons	%	000 Tons	%	000 Tons	%	TOTAL
1961	.5	20.0	2.0	80.0	--	--	--	--	2.5
1962	.8	40.0	1.2	60.0	--	--	--	--	2.0
1963	1.5	55.6	1.2	44.4	--	--	--	--	2.7
1964	2.0	50.0	1.3	32.5	.7	17.5	--	--	4.0
1965	1.3	40.6	1.3	40.6	.6	18.8	--	--	3.2
1966	1.4	53.8	.9	34.6	.3	11.5	--	--	2.6
1967	2.3	69.7	.8	24.2	.2	6.1	--	--	3.3
1968	1.7	68.0	.8	32.0	--	--	--	--	2.5
1969	1.2	37.5	1.5	46.9	.5	15.6	--	--	3.2
1970	.6	33.3	.9	50.0	.3	16.7	--	--	1.8
1971	1.3	39.4	1.4	42.4	.1	3.0	.5	15.2	3.3
1972	1.0	35.7	1.1	39.3	--	--	.7	25.0	2.8
1973	1.7	58.6	.4	13.8	.1	3.5	.7	24.1	2.9
1974	1.1	50.0	.5	22.7	.2	9.1	.4	18.2	2.2
1975	1.0	35.7	.9	32.1	.5	17.9	.4	14.3	2.8
1976	1.0	27.8	1.2	33.3	.6	16.7	.8	22.2	3.6

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

TABLE XVIII-8
IMPORTS OF CANNED SALMON BY NEW ZEALAND:
COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

YEAR	CANADA	JAPAN	TOTAL
1961	.6	.3	.9
1962	.4	.3	.7
1963	.8	.3	1.1
1964	.8	.4	1.2
1965	.8	.5	1.3
1966	.6	.2	.8
1967	.5	.2	.7
1968	.5	.2	.7
1969	.4	.3	.7
1970	.7	.5	1.2
1971	.5	.4	.9
1972	.5	.4	.9
1973	1.0	.5	1.5
1974	.3	.3	.6
1975	.1	.4	.5
1976	.3	.5	.8

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A (1961-1976)

Small quantities from other countries not included in total.

TABLE XVIII-9

IMPORTS OF CANNED SALMON BY
UNITED STATES: COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

YEAR	CANADA	JAPAN	TOTAL
1961	.9	2.2	3.1
1962	.9	2.3	3.2
1963	.2	.3	.5
1964	---	---	---
1965	---	.1	.1
1966	.1	.1	.2
1967	---	.2	.2
1968	1.9	.5	2.4
1969	.6	.7	1.3
1970	---	---	---
1971	.5	.5	1.0
1972	1.9	3.8	5.7
1973	1.0	.7	1.7
1974	1.6	1.7	3.3
1975	---	1.3	1.3
1976	.3	.3	.6

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

TABLE XVIII-10

IMPORTS OF CANNED SALMON BY THE UNITED KINGDOM: COUNTRY OF ORIGIN
(In Thousands of Metric Tons)

	CANADA		JAPAN		U.S.A.		USSR		
YEAR	Tons	%	Tons	%	Tons	%	Tons	%	TOTAL
1961	4.2	19.0	13.3	60.2	1.8	8.1	2.8	12.7	22.1
1962	5.4	9.8	44.9	81.2	3.0	5.4	2.0	3.6	55.3
1963	6.9	20.6	20.6	61.5	3.1	9.3	2.9	8.6	33.5
1964	8.9	23.9	19.6	52.7	6.7	18.0	2.0	5.4	37.2
1965	5.7	13.3	27.4	64.0	7.5	17.5	2.2	5.1	42.8
1966	5.3	18.7	14.7	51.8	6.5	22.9	1.9	6.7	28.4
1967	10.6	26.4	20.9	52.1	7.4	18.5	1.2	3.0	40.1
1968	9.7	22.4	29.3	67.5	1.5	3.5	2.9	6.6	43.4
1969	10.5	36.0	12.6	43.2	3.7	12.7	2.4	8.2	29.2
1970	2.8	11.0	16.3	64.2	3.8	15.0	2.5	9.8	25.4
1971	5.8	19.3	17.3	57.5	4.7	15.6	2.3	7.6	30.1
1972	7.1	23.2	15.0	49.0	7.2	23.5	1.3	4.2	30.6
1973	9.8	40.7	7.2	29.9	6.1	25.3	1.0	4.1	24.1
1974	5.5	36.9	6.3	42.3	2.4	16.1	.7	4.7	14.9
1975	3.7	17.9	9.3	44.9	6.3	30.4	1.4	6.8	20.7
1976	3.9	21.4	8.5	46.7	4.2	23.1	1.6	8.8	18.2

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

TABLE XVIII-11

ANNUAL EXPORTS OF FROZEN SALMON BY COUNTRY, 1961 TO 1976
(In Thousands of Metric Tons)

YEAR	CANADA	UNITED STATES	JAPAN	TOTAL	NET IMPORTS[1]
1961	4.4	Not Avail.	1.4	--	
1962	5.1	Not Avail.	1.6	--	
1963	5.9	Not Avail.	1.2	--	
1964	7.6	Not Avail.	1.4	--	
1965	7.6	4.2	.4	12.2	8.5
1966	9.2	7.9	.2	17.3	13.3
1967	9.7	7.5	.0	17.2	13.5
1968	10.1	7.0	.0	17.1	13.5
1969	12.9	13.1	.0	26.0	22.3
1970	10.6	12.8	.3	23.7	18.8
1971	13.5	10.2	.4	24.1	19.9
1972	17.6	13.4	*	31.0	26.0
1973	21.1	25.3	.2	46.6	40.1
1974	14.2	11.8	.1	26.1	20.5
1975	14.1	20.7	1.4	36.2	30.9
1976	12.4	17.4	2.3	32.1	26.5

Source: Yearbook of Fishery Statistics, Fishery Commodities, F.A.O. (1961-1976)

[1]Exports between producing countries have been deducted from total.

*Less than 50 metric tons

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